EXHIBIT B

UNITED STATES GOVERNMENT
FEDERAL COMMUNICATIONS COMMISSION

MEMORANDUM

Date: May 3, 1996

Reply to Attn of: Thomas W. Phillips

Subject: Test of Fusion Lighting Microwave RF Light, Model Solar 1000

To: Chief, Customer Service Branch

The subject device is an RF light which operates at 2.4 to 2.5 GHz. It was tested for compliance with the radiated and line conducted emission limits for RF lights in Sections 18.305(c) and 18.307(c). It was also tested for compliance with the radiated emission limits of Section 18.305(b) above 1000 MHz.

The maximum radiated emission in the 30 to 1000 MHz range was 6.5 dB below the limit at a frequency of 45.6 MHz. The maximum line conducted emission was 6.9 dB below the limit at a frequency of 479 kHz. Above 1000 MHz the maximum emission observed outside the 2.4 to 2.5 GHz band up to 18 GHz was 4.5 dB below the limit at a frequency of 8372 MHz.

Within the 2.4 to 2.5 GHz band the maximum measured field strength was 1.38 V/m peak and 0.224 V/m average at 3 meters.

JW

EXHIBIT C

FEDERAL COMMUNICATIONS COMMISSION

Customer Service Branch
7435 Oakland Mills Road, Columbia, MD 21046
Phone: (301) 362-3042, Fax: (301) 3442050
E-mail: rlaforge@fcc.gov www site:http://www.fcc.gov
FROM: Ray LaForge DATE: March 5, 1999
TO: Michael Ury
PAGES: 1
REFERENCE: Your inquiry

Dear Mr. Ury:

In regard to your questions the following response is provided:

The Commission has established a policy for measurements taken above 1 GHz using a spectrum analyzer wiht a resolution bandwidth of 1 MHz and a Video bandwidth of 10 Hz to produce an average field strength value for EMI measurements. Originally, we accepted this method for AM and spread spectrum measurements. However, in order to be consistent we now also accept this procedure for other types of systems including FM and the type of modulation typically used in RF lighting. Be sure to take the measurements in "linear mode" as set on the test equipment.

I hope this is responsive to your inquiry. If you have any further questions, please don't hesitate to call.

Ray LaForge
FCC-OET
Customer Service Branch

EXHIBIT D

fusionLighting®

Filter Feasibility for Fusion Lighting Technology

During the course of Docket 98-42 questions have arisen as to the feasibility of adding filters to Fusion's lamps in order to reduce emissions in the DARS band. Fusion commissioned Dr. Kawther Zaki of K.A.Z. Consulting, Inc. to investigate how this might be accomplished.[1] Dr. Zaki's study is useful from a theoretical standpoint. As a practical matter, however, most of Dr. Zaki's proposals will not work in our current lamp or any magnetron powered lamp architecture we have investigated for future deployment. To the extent any of Dr. Zaki's proposals could theoretically be implemented, the reduction in out-of-band emissions would not be significant. The cost to Fusion, however, would be prohibitive.

Dr. Zaki investigated two types of filters that might be inserted between our magnetron and the lamp bulb load. The first is a Band Pass filter designed to reduce all out of band emissions. The second filter type is a Band Stop filter designed to specifically protect the DARS frequency band.

Dr. Zaki investigated 2,3, and 4 pole Band Pass filter designs. This study shows that the more filter stages used, the sharper the filtration and the greater the attenuation of the out of band signal. Unfortunately this study also shows that the band pass filter generates a phase shift between the magnetron and the load. A phase shift of more than 10 degrees can induce magnetron moding, a catastrophic failure condition which will destroy a magnetron in a matter of minutes. A two-pole filter can induce a phase shift of +10 to -12 degrees. A three-pole filter can produce over 70 degrees of phase shift, the four-pole design is even worse. A two-pole filter yields only 9 to 13 db of attenuation and is marginally possible while the other two designs are not feasible.

The second filter type investigated by Dr. Zaki is the Band Stop filter. This filter cuts out noise only in the DARS band. This approach should have minimum phase shift associated with it, although we don't know how much. The maximum benefit of such a filter in the DARS band was found to be only 15 dB of attenuation.

The Band Stop filter would require the addition of at least 20cm of wave-guide and a two pole Band Pass filter would add 19cm of wave-guide. Considering that our existing wave-guide is only 12 cm. long, adding 19-20cm. will double the size of the lamp. I estimate that this will add significantly to our cost. Moreover, unlike standard HID ballasts, the RF ballast must be mounted in close proximity to the bulb. Pole mounting such a lamp would be cost-prohibitive, making such a lamp unmarketable for many significant applications. Fusion has taken pains to reduce the size and weight of its light as much as possible in order to deal with wind and safety issues. Dramatically increasing the size of the light would not be prudent, would be expensive, and serve little purpose.

Respectfully submitted,

Michael Ury
VP Principal Engineer

[1] Dr. Zaki is a professor of electrical engineering at the University of Maryland

Fusion Lighting, Inc. • 7524 Standish Place • Rockville, MD 20855 USA
Tel: 301 284 7200 • Fax: 301 926 7258

UNITED STATES GOVERNMENT
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Within the 2.4 to 2.5 GHz band the maximum measured field strength was 1.38 V/m peak and 0.224 V/m average at 3 meters.

TWP

FEDERAL COMMUNICATIONS COMMISSION

Customer Service Branch
7435 Oakland Mills Road, Columbia, MD 21046
Phone: (301) 362-3042, Fax: (301) 3442050
E-mail: rlaforge@fcc.gov www site:http://www.fcc.gov
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I hope this is responsive to your inquiry. If you have any further questions, please don't hesitate to call.

Ray LaForge
FCC-OET
Customer Service Branch

REPORT ON

Filter Feasibility & Design Study

Prepared for

Fusion Technology

By

K. A. Z. Consulting, Inc.

10841 Willow Run Ct.

Potomac, MD 20854

November, 2000

1. INTRODUCTION

This is a trade off study for the design of a filter to be used in Fusion's system. The problem as we understand it can be stated as follows:
A magnetron source has its output coaxially coupled to a rectangular waveguide. The waveguide cross section is 71.44 mm X 43.2 mm (i.e. 2.813" X 1.700"). The magnetron is matched to the waveguide over the frequency band of interest (2430 MHz to 2470 MHz) using a rectangular tuning obstacle in the waveguide. The waveguide is coupled to the lamp through a coupling iris near the edge of the waveguide. This structure is shown in Fig. 1 (which is re-drawn from the sketch supplied by Fusion). The spectrum of the output signal of the magnetron contains the "Fusion Band" 2430 MHz to 2470 MHz, which contains all the signals required for the operation of the lamp, and also contains "spurious" signals in the Digital Audio Radio Satellite (DARS) band, which may cause Electromagnetic Interference (EMI) into the DARS receivers. Typical measured spectrum of the magnetron output supplied by Fusion is shown in Fig. 2. The problem addressed here is to investigate ways of substantially reducing the spurious signals, while introducing minimal effects on the desired signals and on the magnetron match. It is important to recognize that the magnetron is a nonlinear device whose output power, frequency, and stability are sensitive to the impedance match seen at its output over a wide frequency band.

Two approaches are considered in this study. The first approach is to investigate the insertion of a bandpass filter at the output port of the magnetron, in the waveguide section. The bandpass filter requirements are to present an excellent match over the desired band, with minimum insertion loss and minimum phase distortion (i.e. linear phase). The study will present trade off between the attenuation of the DARS band vs. the number of poles of the filter, its size and its insertion loss for the desired frequency band. This approach is quite feasible to implement with confidence that the practically achieved results will be close to the simulations presented.

The second approach is to insert an absorption matched band stop filter that notches out the DARS band, and introduces minimum attenuation and phase shift over all other bands, including the desired band. The main advantage of the absorption filter is that it can present a broad-band matched condition, thus introduces no reactance to the magnetron. However, the disadvantage is that it is expected the filter cannot introduce a large attenuation to the DARS band (probably limited to about 15 dB), it needs more components (a T-junction, a bandpass filter, and a load), and is somewhat larger in size. Furthermore, this approach will need further detailed analysis and investigation to ensure that the desired match can indeed be achieved over a broadband. Thus it is not certain that this approach can be realized successfully in practice.

2. BANDPASS FILTERS TRADE OFF

We have considered three waveguide bandpass filters of various complexities. These are : two pole inductive windows, three pole inductive windows, and four pole dual mode elliptic function filter of circular waveguide cavities. Common requirements on all the filters are:

Pass band: 2.43 GHz to 2.47 GHz
Important Stop Band: 2.32 GHz to 2.345 GHz
Filter Return Loss over the pass band: Minimum of 26 dB
Filter Material: Aluminum
Temperature range: 10°C to 60°C
Interface: Rectangular waveguide: 71.44 mm X 43.2 mm

Two Pole Filter:
The theoretical simulated response of an inductive windows two pole waveguide bandpass filter is shown in Fig. 3 and Fig. 4. The maximum insertion loss over the pass band is .03 dB, maximum group delay variation is 0.4 nanosec. and the minimum attenuation presented to the DARS band is 9 dB. It is expected that the actual insertion loss will be higher than the theoretical loss by about .05 dB. The approximate length of this filter will be 190 mm (about 7.5 Inches), and it's cross section will be the same as the waveguide (i.e. 71.44 mm X 43.2 mm).

Three Pole Filter:
The theoretical simulated response of an inductive windows three pole waveguide bandpass filter is shown in Fig. 5 and Fig. 6. The maximum insertion loss over the pass band is .09 dB, maximum group delay variation is 1.9 nanosec. and the minimum attenuation presented to the DARS band is 27 dB. It is expected that the actual insertion loss will be higher than the theoretical loss by about .05 dB. The approximate length of this filter will be 285 mm (about 11.2 Inches), and it's cross section will be the same as the waveguide (i.e. 71.44 mm X 43.2 mm).

Four Pole Filter:
The theoretical simulated response of an elliptic function four pole dual mode circular TE111 waveguide bandpass filter is shown in Fig. 7 and Fig. 8. The maximum insertion loss over the pass band is .09 dB, maximum group delay variation is 2.6 nanosec. and the minimum attenuation presented to the DARS band is 55 dB. It is expected that the actual insertion loss will be higher than the theoretical loss by about .05 dB. The approximate length of this filter will be 145 mm (about 5.6 Inches), and it's cross section will be circular of about 114 mm (4.5 Inches). The filter would have an interface to the rectangular waveguide of 71.44 mm X 43.2 mm.

Table 1 presents a summary comparison of the performance of the three types of bandpass filters. Figure 9 shows sketches of the three filters showing their approximate outline dimensions.

Table 1 Summary of Bandpass Filters Performance

Filter Type	Max. Pass Band Insertion Loss (dB)	Min. Ins. Loss Over the DARS Band (dB)	Max. Group Delay Variation (N. Sec.)	Approximate Length (mm)	Cross Section Dimensions (mm)
2-Pole Inductive Windows	.08	9	.4	190	71.44 X 43.2
3-Pole Inductive Windows	.14	27	1.9	285	71.44 X 43.2
4-Pole Dual Mode Elliptic Function	.14	55	2.6	145	114 Diameter (circular)

3. BAND REJECT ABSORPTION FILTER

The concept of the band reject absorption filter is shown in Fig. 10. The idea is to introduce a T-junction in the waveguide. In the perpendicular arm of the T-junction a bandpass filter, terminated in a matched load, is include that has its pass-band in the DARS frequency band. In the pass band of this filter, the energy leaks through it and gets absorbed by the load. In the stop band of the filter the T-junction appears to have a virtual short circuit on its perpendicular arm, and therefore all the energy passes through the straight arm.

Although conceptually simple, this type of band reject filter needs further study to confirm the feasibility of achieving a reasonably good match over a broad band of frequency. Since the T-junction is a lossless reciprocal 3-port network, it is known that it cannot be matched on all three ports. However, the introduction of the frequency selective filter, which has a load at its output port, may enable the matching of the junction and the achievement of the desired performance. In principal the attenuation characteristics of the two port network consisting of the straight arms of the T-junction should be the reciprocal of the bandpass filter characteristics in the perpendicular arm of the T-junction. Thus the pass band of the filter becomes the stop band of the two port, and the stop band of the filter is the pass band of the two port.

4. CONCLUSIONS

The trade off analysis performed indicates that adequate rejection of the DARS band can be achieved by inserting a bandpass filter at the output of the magnetron source, preferably after the matching section. The filters studied can provide rejections ranging from about 9 dB to about 55 dB, with very low loss (less than 0.2 dB). The match of these filters is designed to be better than 26 dB over their pass bands, which should present good conditions to the magnetron. The approximate sizes of the filters has been estimated, and presented in the study.

The concept of a band reject absorption filter was introduced, but this type of filter requires further feasibility study.

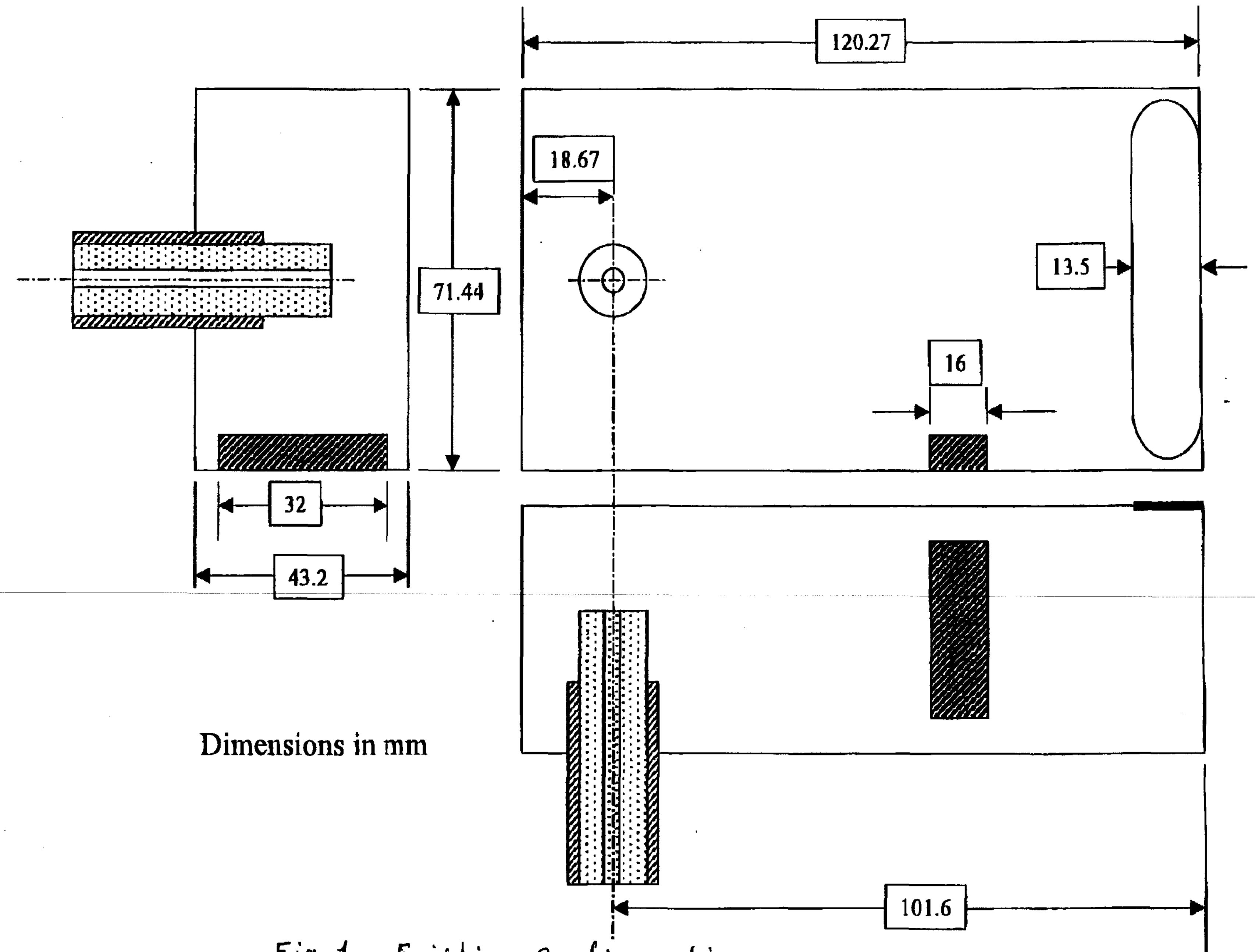
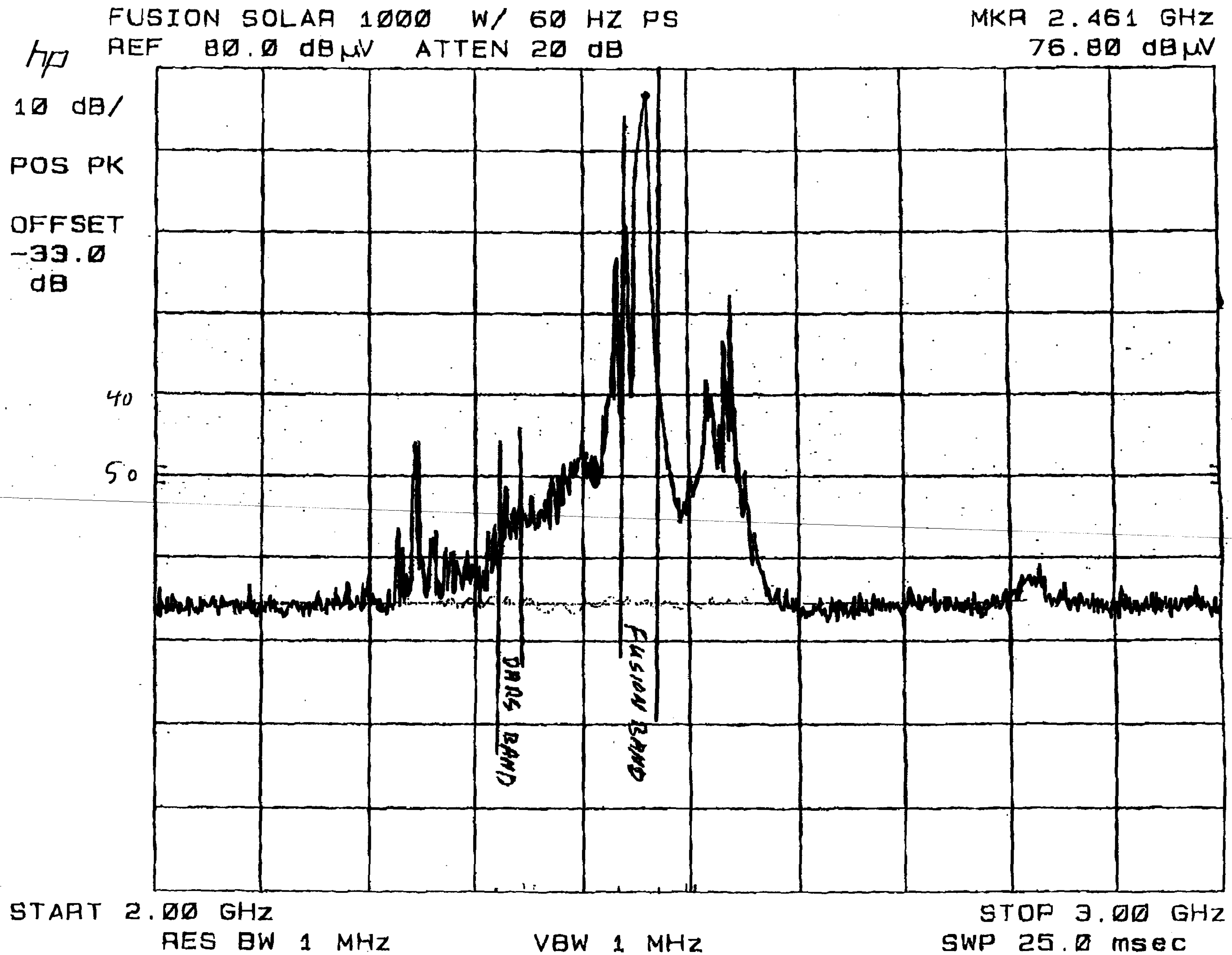


Fig. 1. Existing Configuration

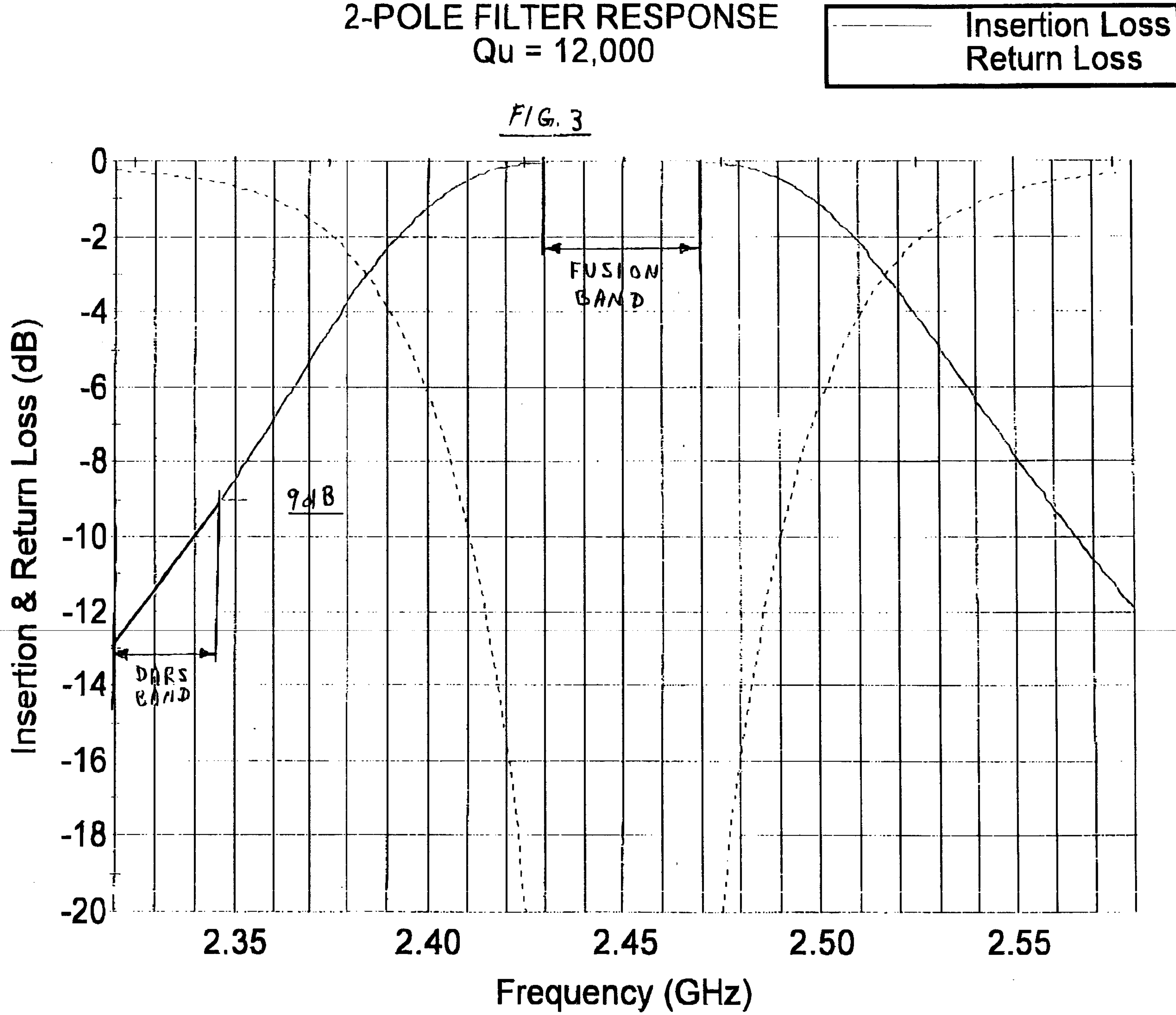
Fig. 2



FUSION SOLAR 1000 W/ 60 HZ PS
REF 80.0 dBμV ATTEN 20 dB
MKR 2.461 GHz
76.80 dBμV
hp
10 dB/
POS PK
OFFSET
-33.0
dB
40
50
DRDS BAND
FUSION BAND
START 2.00 GHz
STOP 3.00 GHz
RES BW 1 MHz
VBW 1 MHz
SWP 25.0 msec

2-POLE FILTER RESPONSE
Qu = 12,000

FIG. 3



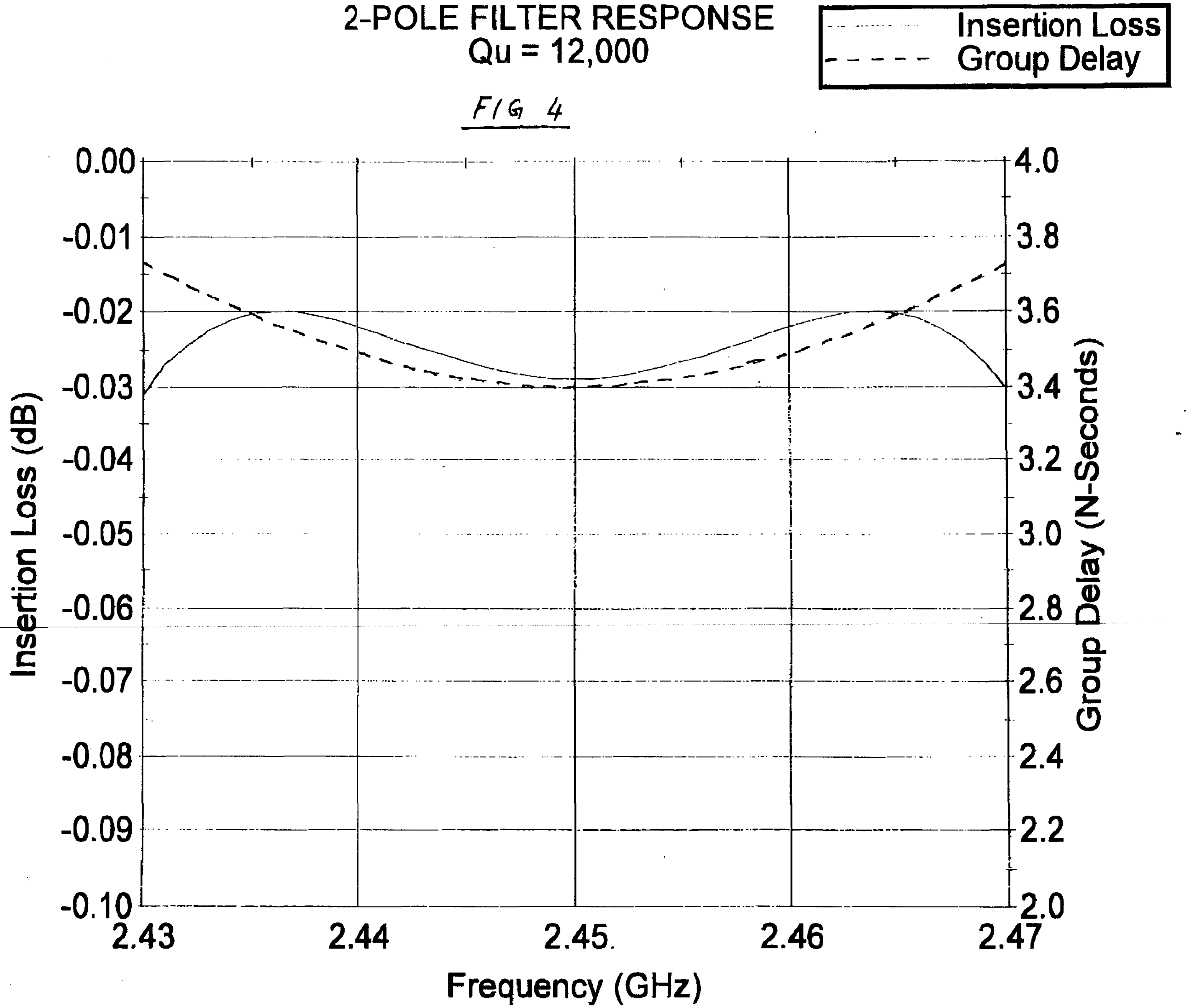
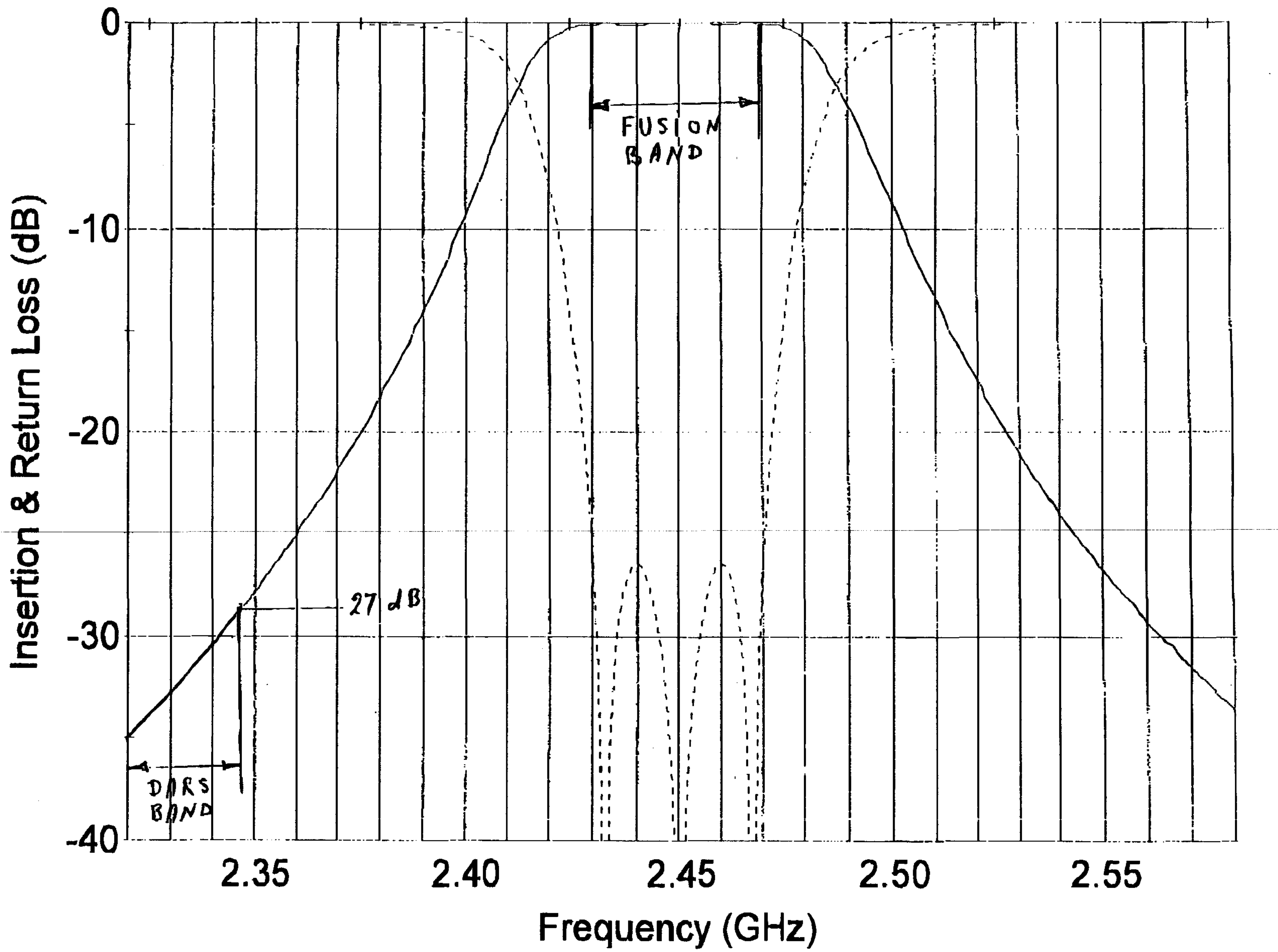

2-POLE FILTER RESPONSE
Qu = 12,000
Insertion Loss
Group Delay
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
Insertion Loss (dB)
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
Group Delay (N-Seconds)
2.43
2.44
2.45
2.46
2.47
Frequency (GHz)

FIG 4

3-POLE FILTER RESPONSE
Qu = 12,000

FIG. 5



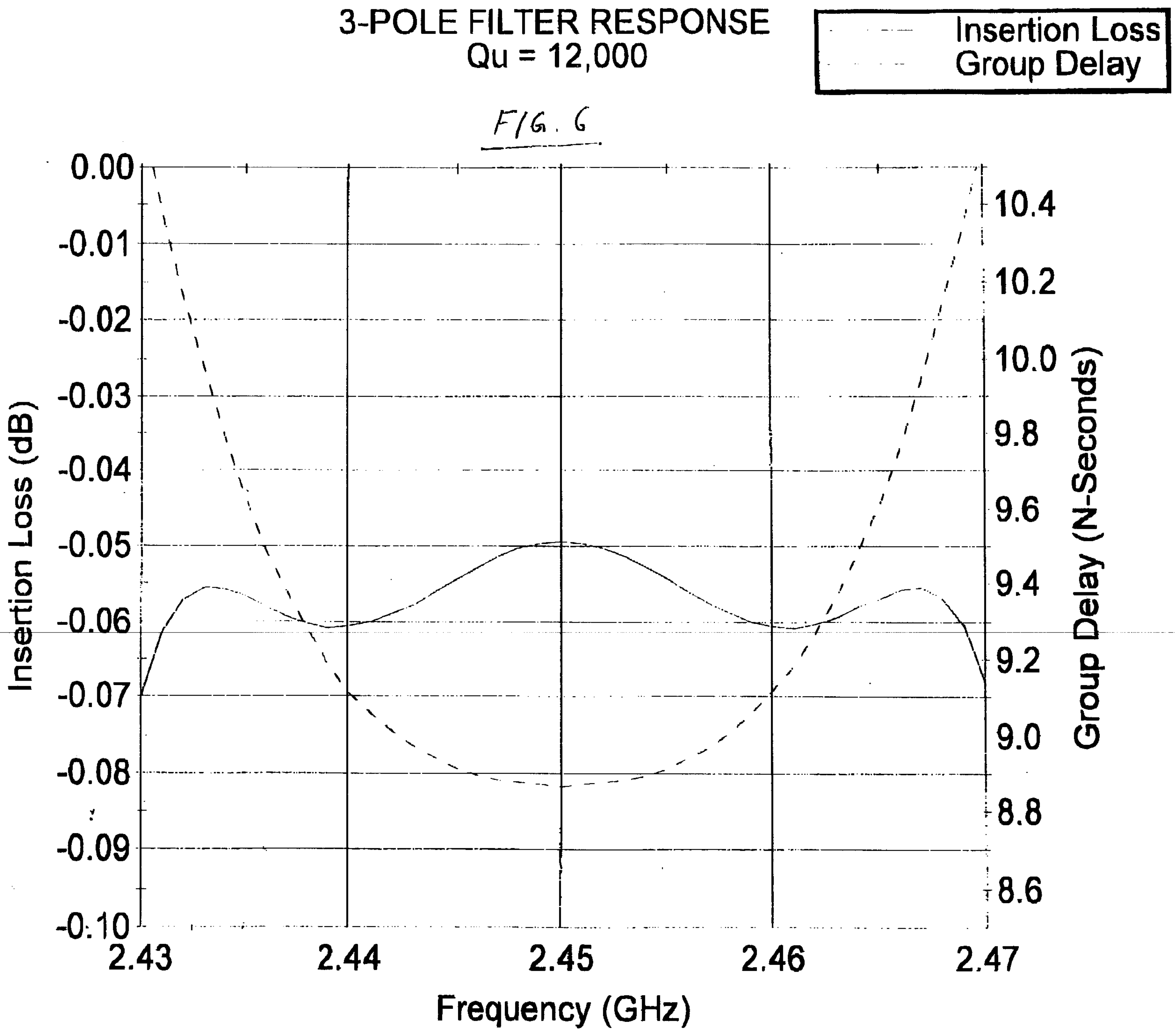
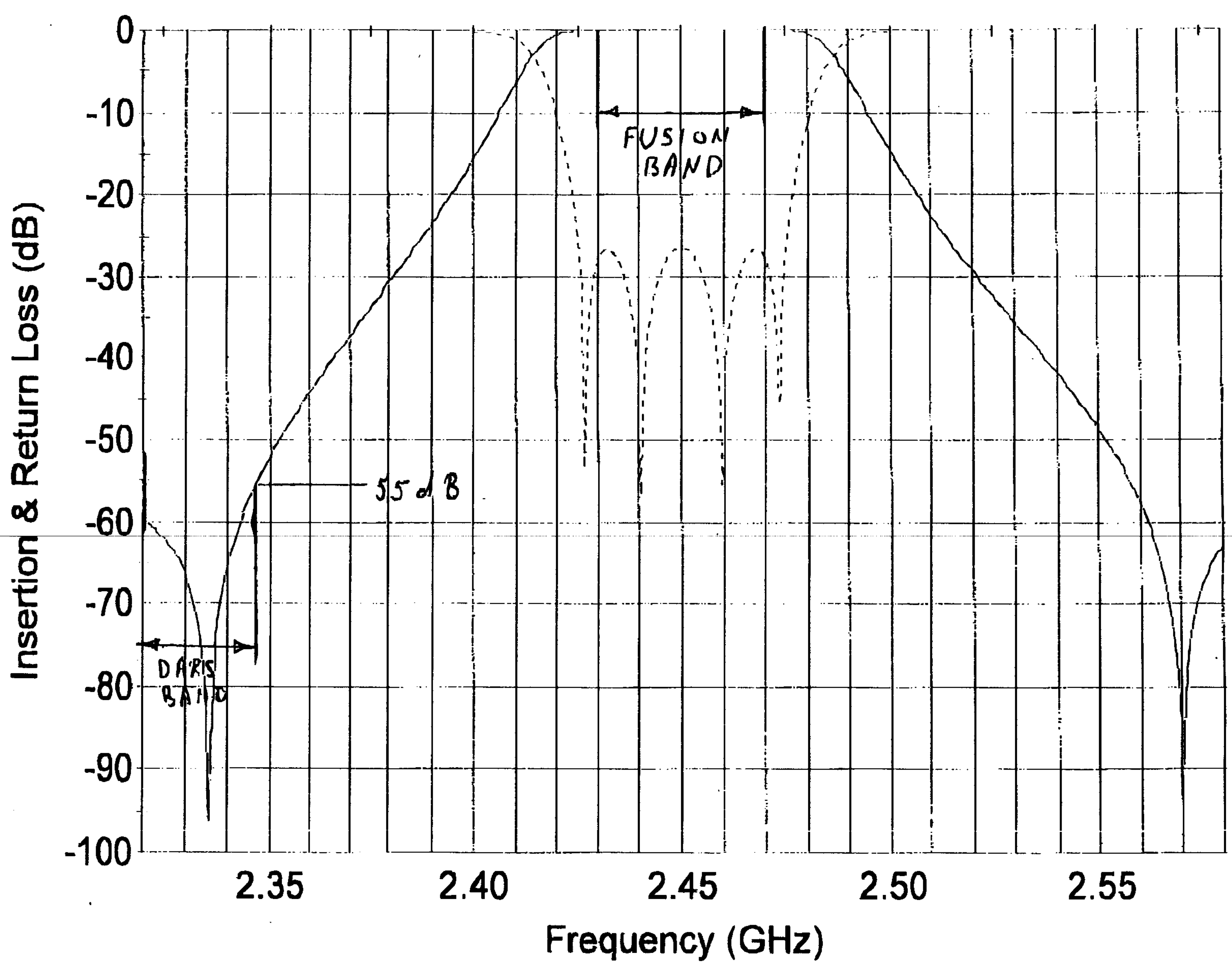

3-POLE FILTER RESPONSE
Qu = 12,000
Insertion Loss
Group Delay
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
Insertion Loss (dB)
10.4
10.2
10.0
9.8
9.6
9.4
9.2
9.0
8.8
8.6
Group Delay (N-Seconds)
2.43
2.44
2.45
2.46
2.47
Frequency (GHz)

FIG. 6

4-Pole FILTER RESPONSE

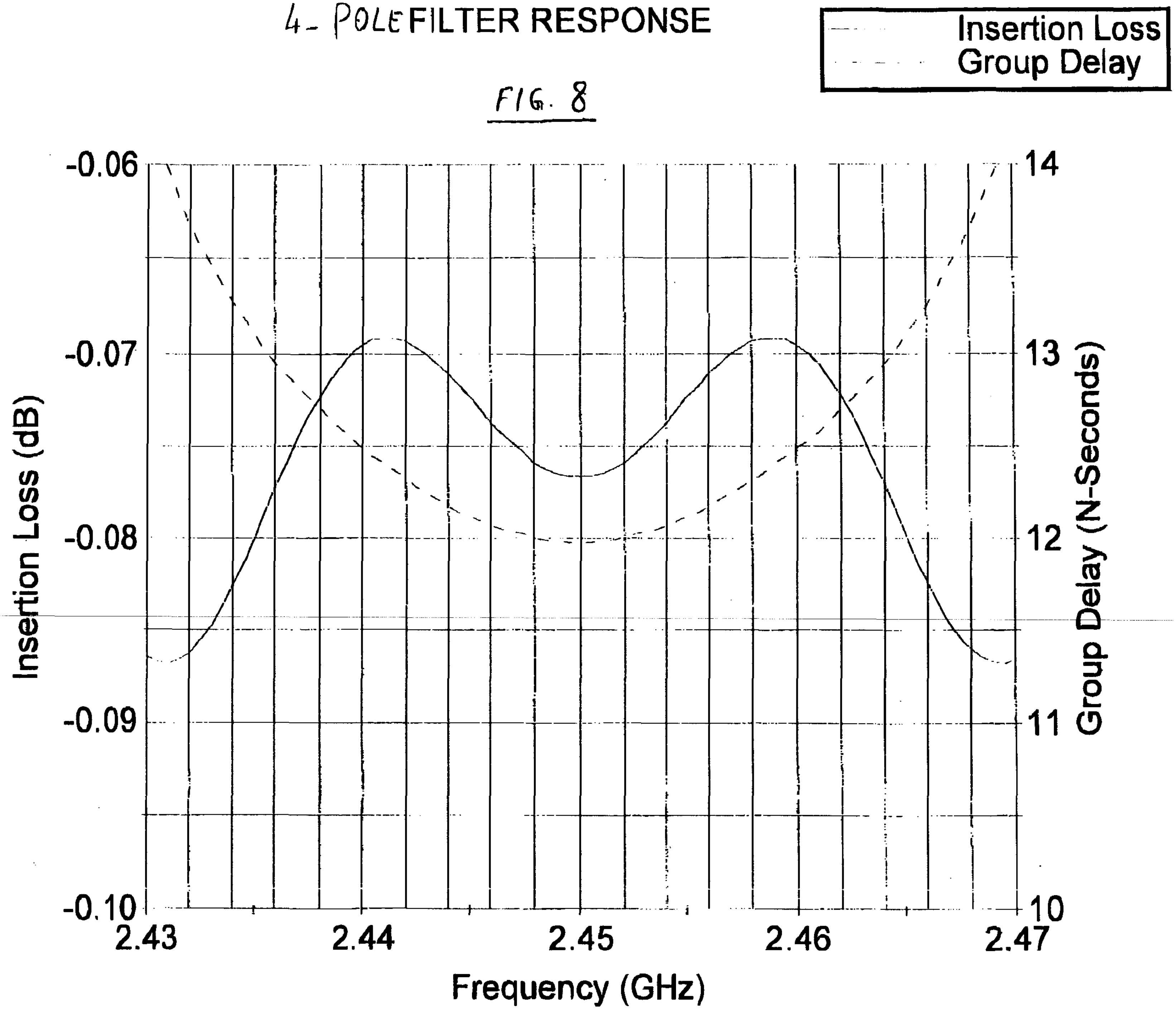
Insertion Loss
Return Loss

FIG. 7



4- POLE FILTER RESPONSE

FIG. 8



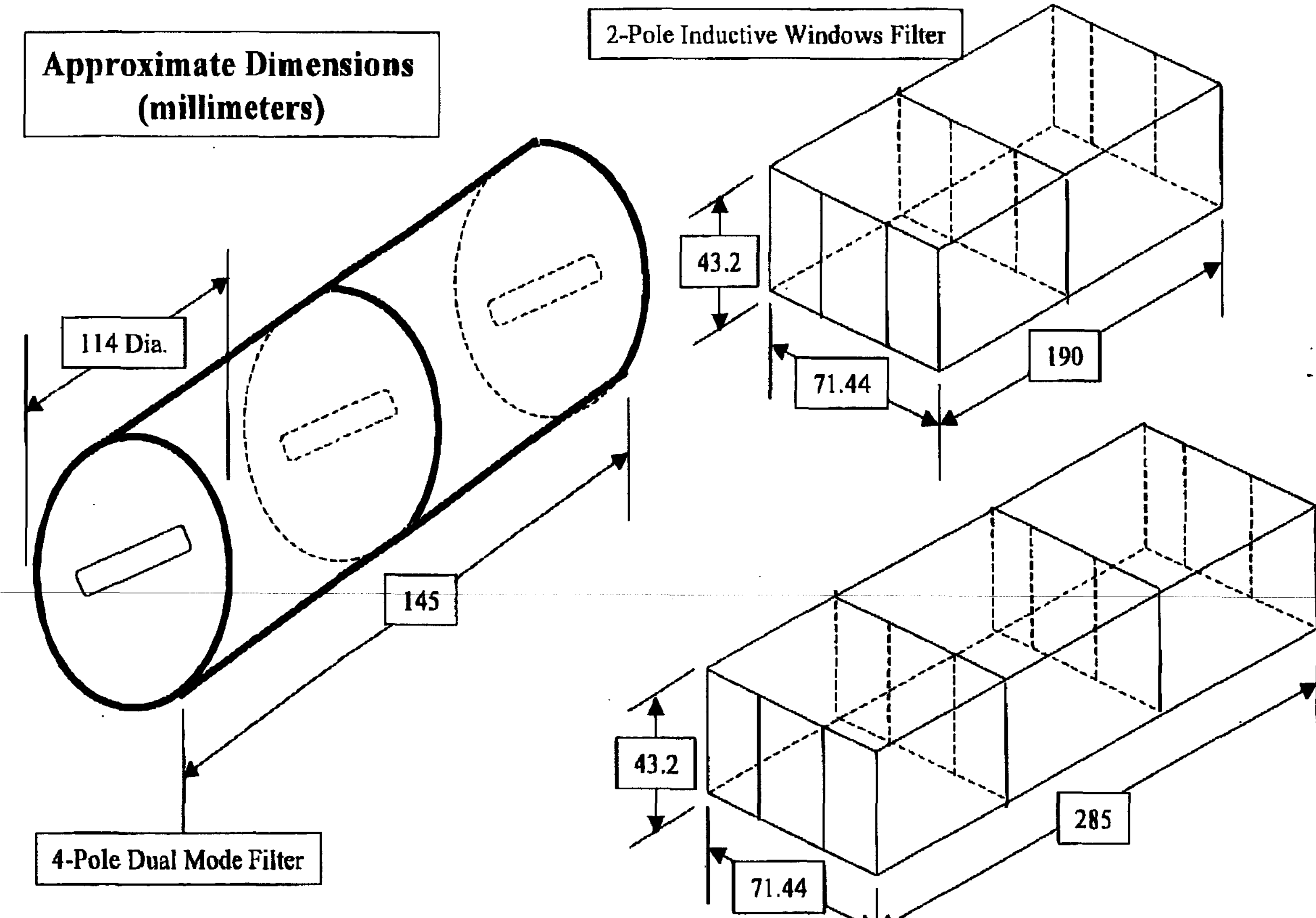


Fig. 9 Sketches of the Band Pass Filters Configurations

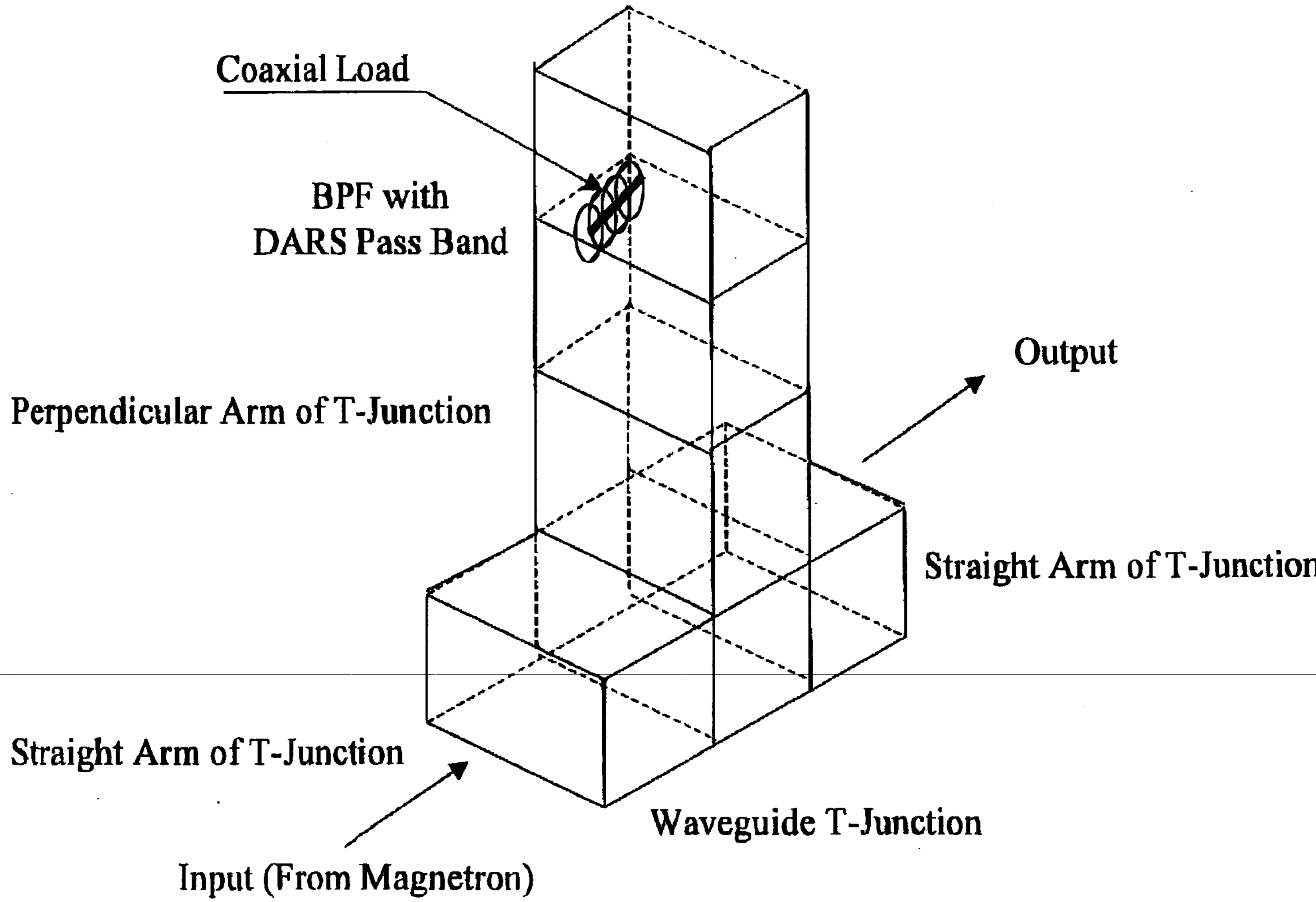


Fig. 10 Concept of Absorption Band Reject Filter

Michael Ury

From: "Kawthar A. Zaki" <zaki@Glue.umd.edu>
To: <fury@bcn.net>
Sent: Saturday, November 11, 2000 3:21 PM
Attach: FiltersResponses.xls
Subject: Filter's phase responses (fwd)

==

Kawthar A. Zaki, Professor. Office: AVW 2349
Electrical and Computer Engineering Department
A.V. Williams Building
University of Maryland, College Park MD 20742
<zaki@eng.umd.edu>
Tel: 301-405-3674, Fax: 301-314-9281

==

——— Forwarded message ———
Date: Sat, 11 Nov 2000 12:14:48 -0500 (EST)
From: Kawthar A. Zaki <zaki@Glue.umd.edu>
To: Michael <fur@bcn.net>
Cc: kzaki@ieee.org
Subject: Filter's phase responses

Dear Micheal:
I computed the phase responses for each of the three filters in the report. The attached file shows these responses. Also I computed the phase deviation from linear phase over the passband for each of the filter. I believe that what is important for the magnetron output frequency and stability is the phase deviation from linear and not the absolute phase. This is because in the ideal case the magnetron likes to see a perfect match which means a zero attenuation and perfect linear phase over the frequency band of interest. Please review the attached file and give me a call if you have any question.
Best Regards,

==

Kawthar A. Zaki, Professor. Office: AVW 2349
Electrical and Computer Engineering Department
A.V. Williams Building
University of Maryland, College Park MD 20742
<zaki@eng.umd.edu>
Tel: 301-405-3674, Fax: 301-314-9281

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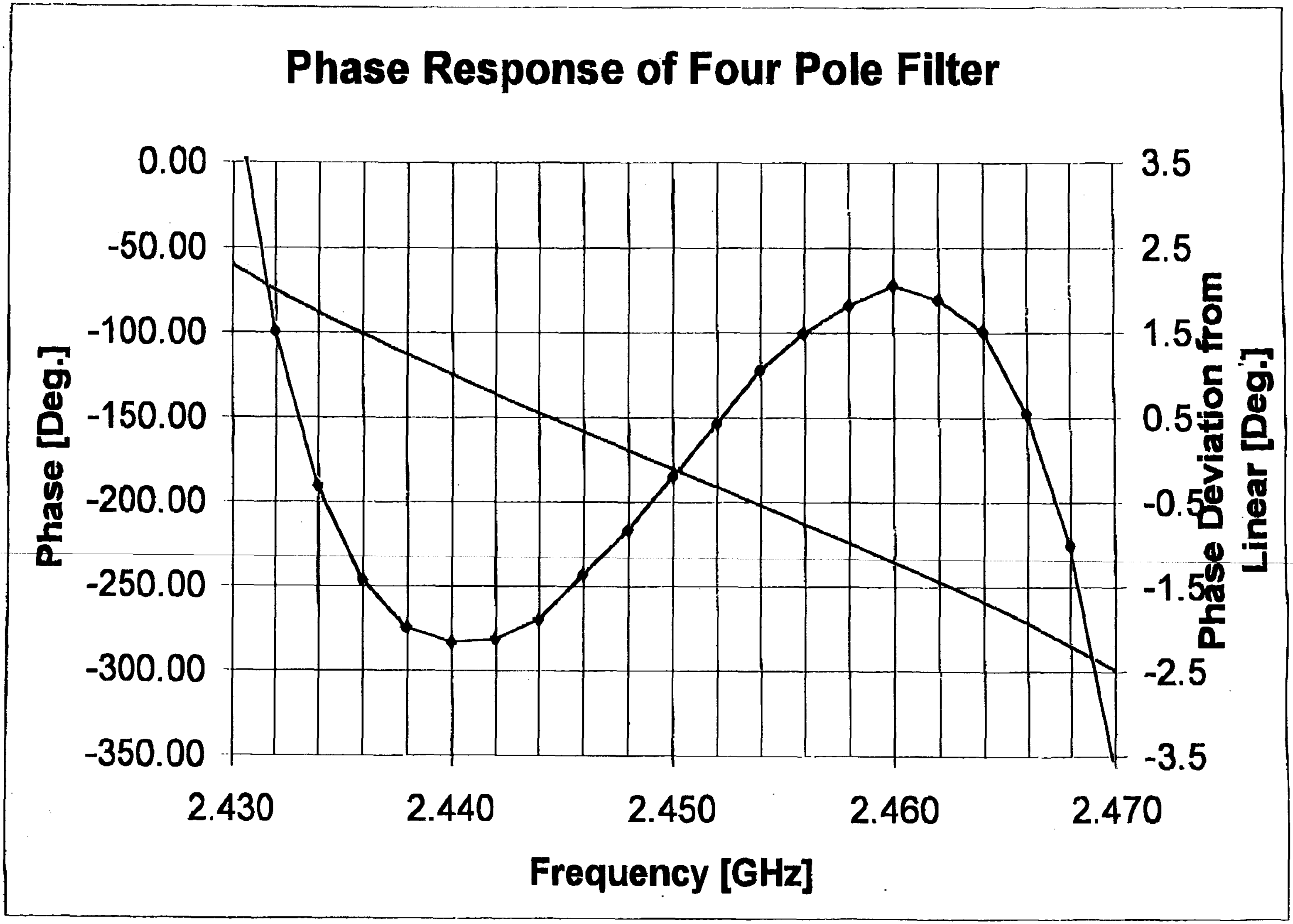
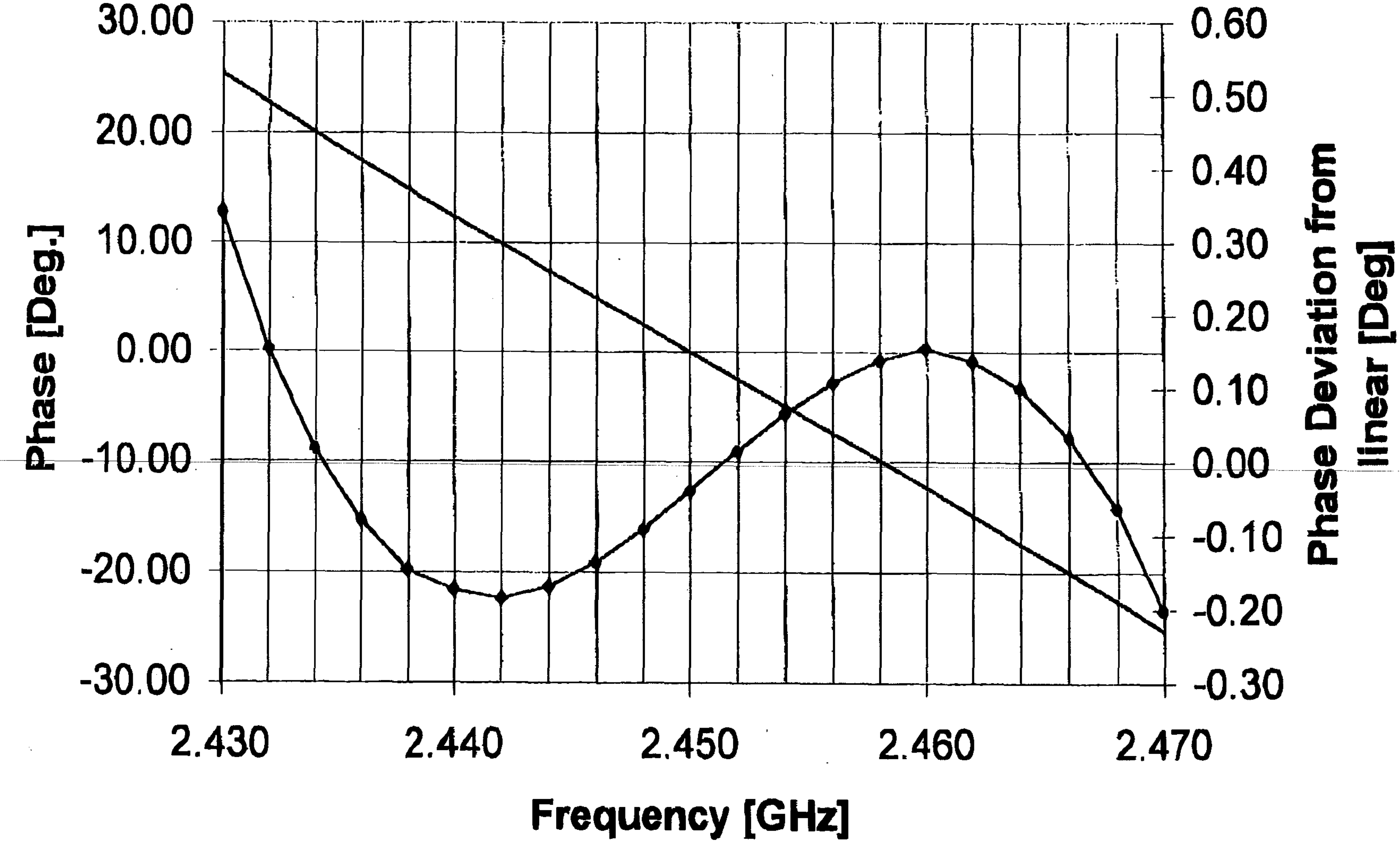
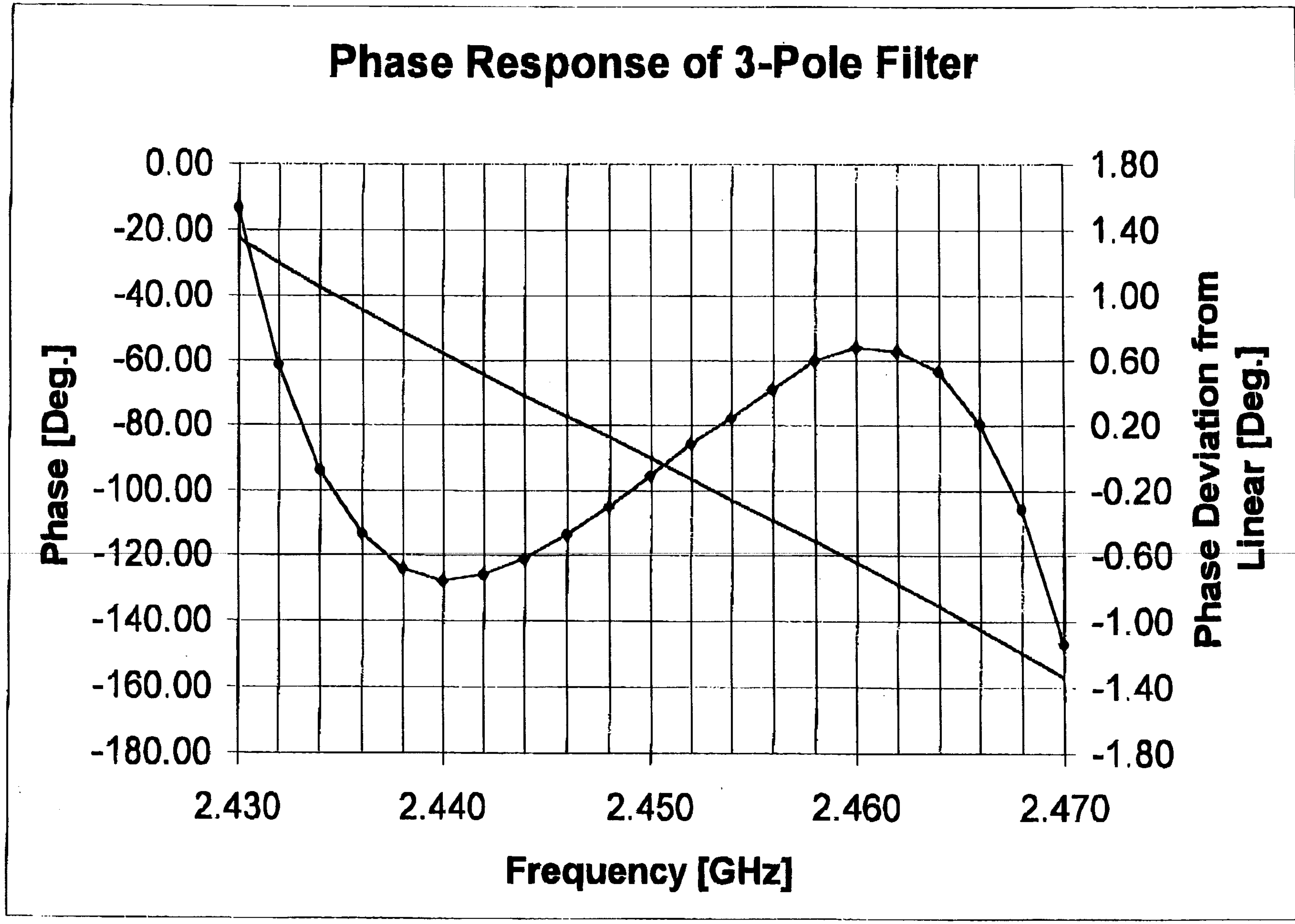

Phase Response of Four Pole Filter
Phase [Deg.]
0.00
-50.00
-100.00
-150.00
-200.00
-250.00
-300.00
-350.00
Phase Deviation from Linear [Deg.]
3.5
2.5
1.5
0.5
-0.5
-1.5
-2.5
-3.5
2.430
2.440
2.450
2.460
2.470
Frequency [GHz]

Phase Response of 2-Pole Filter




Phase Response of 3-Pole Filter
0.00
-20.00
-40.00
-60.00
-80.00
-100.00
-120.00
-140.00
-160.00
-180.00
Phase [Deg.]
1.80
1.40
1.00
0.60
0.20
-0.20
-0.60
-1.00
-1.40
-1.80
Phase Deviation from Linear [Deg.]
2.430
2.440
2.450
2.460
2.470
Frequency [GHz]

Conversion for dB to gain or attenuation

Voltage ratio			Power Ratio		
dB	Gain	Loss	dB	Gain	Loss
0	1	1	0	1	1
0.1	1.011579	0.988553	0.1	1.023293	0.977237
0.2	1.023293	0.977237	0.2	1.047129	0.954993
0.3	1.035142	0.966051	0.3	1.071519	0.933254
0.4	1.047129	0.954993	0.4	1.096478	0.912011
0.5	1.059254	0.944061	0.5	1.122018	0.891251
0.6	1.071519	0.933254	0.6	1.148154	0.870964
0.7	1.083927	0.922571	0.7	1.174898	0.851138
0.8	1.096478	0.912011	0.8	1.202264	0.831764
0.9	1.109175	0.901571	0.9	1.230269	0.812831
1	1.122018	0.891251	1	1.258925	0.794328
1.1	1.135011	0.881049	1.1	1.28825	0.776247
1.2	1.148154	0.870964	1.2	1.318257	0.758578
1.3	1.161449	0.860994	1.3	1.348963	0.74131
1.4	1.174898	0.851138	1.4	1.380384	0.724436
1.5	1.188502	0.841395	1.5	1.412538	0.707946
1.6	1.202264	0.831764	1.6	1.44544	0.691831
1.7	1.216186	0.822243	1.7	1.479108	0.676083
1.8	1.230269	0.812831	1.8	1.513561	0.660693
1.9	1.244515	0.803526	1.9	1.548817	0.645654
2	1.258925	0.794328	2	1.584893	0.630957
5	1.778279	0.562341	5	3.162278	0.316228
10	3.162278	0.316228	10	10	0.1
15	5.623413	0.177828	15	31.62278	0.031623
20	10	0.1	20	100	0.01
25	17.78279	0.056234	25	316.2278	0.003162
30	31.62278	0.031623	30	1000	0.001
35	56.23413	0.017783	35	3162.278	0.000316
40	100	0.01	40	10000	0.0001

To Dr. K. Zaki
301 405 9281

From M. Ury
413 528 2179

M. Ury

Oct 25, 00

Ref.: Filter design study

Glad we have started.

If you want to talk directly to our expert, he is Dr. Jim Simpson, W. 301 284 7245 and Home 301 963 4916. He believes some sort of trap for the satellite signal may be possible in the waveguide, but all possibilities should be explored.

I have attached some basic dimensions for the cavity. Data on the magnetron source is being faxed directly to you by someone at Fusion.

The DARS band (digital audio radio satellite) is 2320 to 2345 MHz. For purposes of the study assume all of our signal is between 2430 and 2470 MHz. I have attached a typical spectrum.

Jim says we design our systems so the magnetron is tuned to achieve a near perfect match to the waveguide as seen by the magnetron. We measure this by inserting a network analyzers into the waveguide at the magnetron antenna and effectively running at full power. You do this with something called a dynamic launcher made for us by the Japanese.

That should allow you to define the source impedance, but we are very vague about the load impedance. We believe the bulb is a bout 300 ohms with a additional unknown reactive component. We will have to talk about this and I will get the right person on the phone. The coupling slot and the secondary cavity formed from transparent conducting mesh is a low Q cavity and was empirically designed over many years. We tune to it by adjusting dimensions to achieve optimal light output and a good magnetron match.

Again we need some possible concepts for reducing our EMI in the DARS band. It would be great if it also reduced it elsewhere, but we need to know tradeoffs.

Again, for a range of DARS attenuation, we need estimates of our magnetrons signals attenuation and phase shift vs frequency.

We will talk shortly as soon as you have digested this.

FUSION SOLAR 1000 W/ 60 HZ PS
REF 80.0 dBμV ATTEN 20 dB

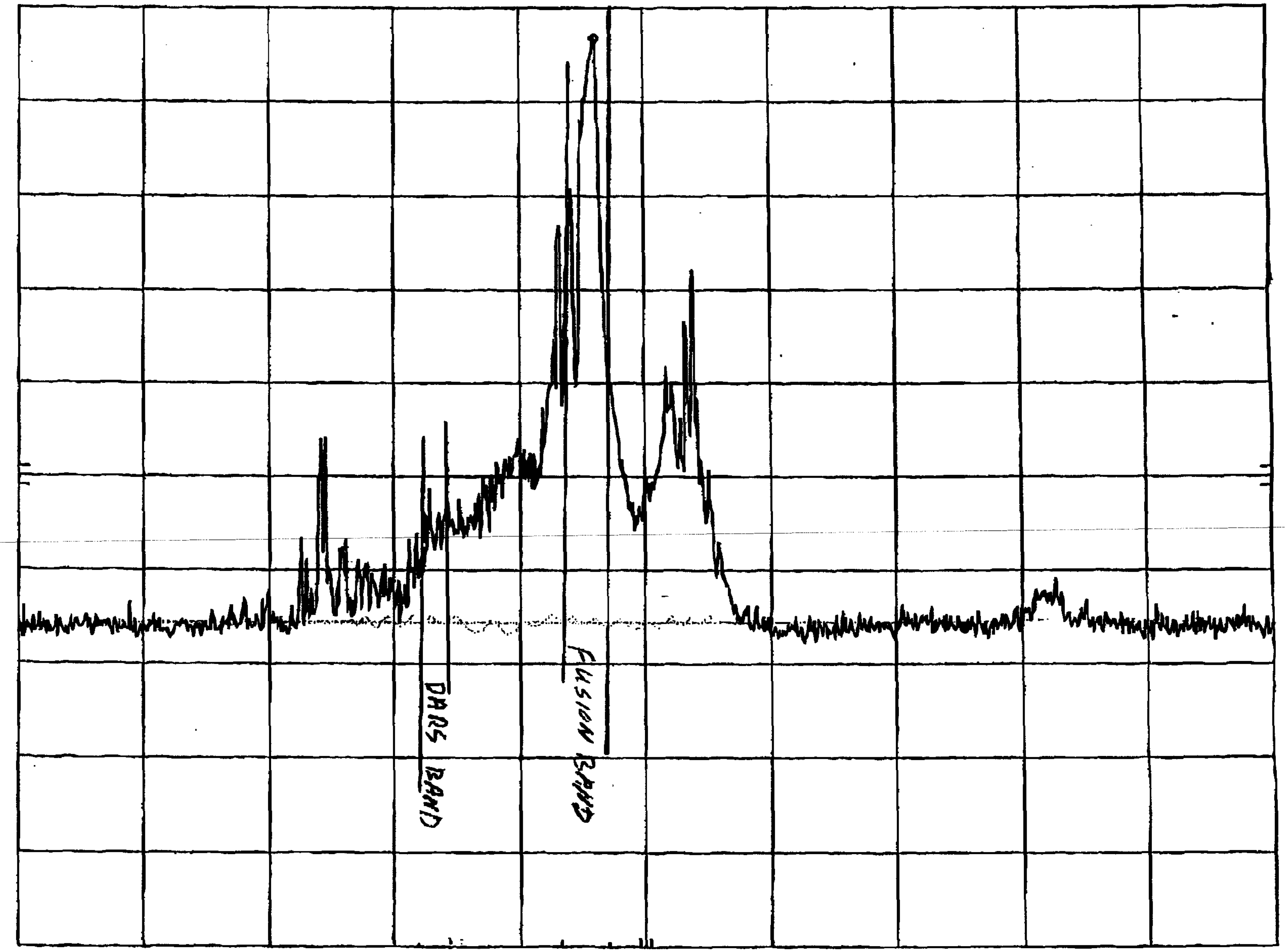
MKR 2.461 GHz
76.80 dBμV

hp

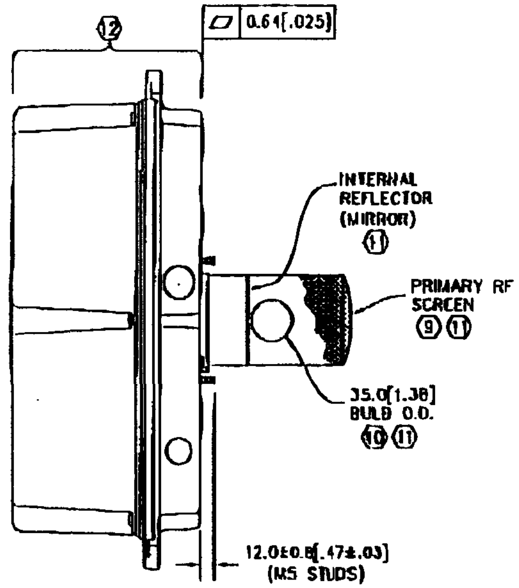
10 dB/

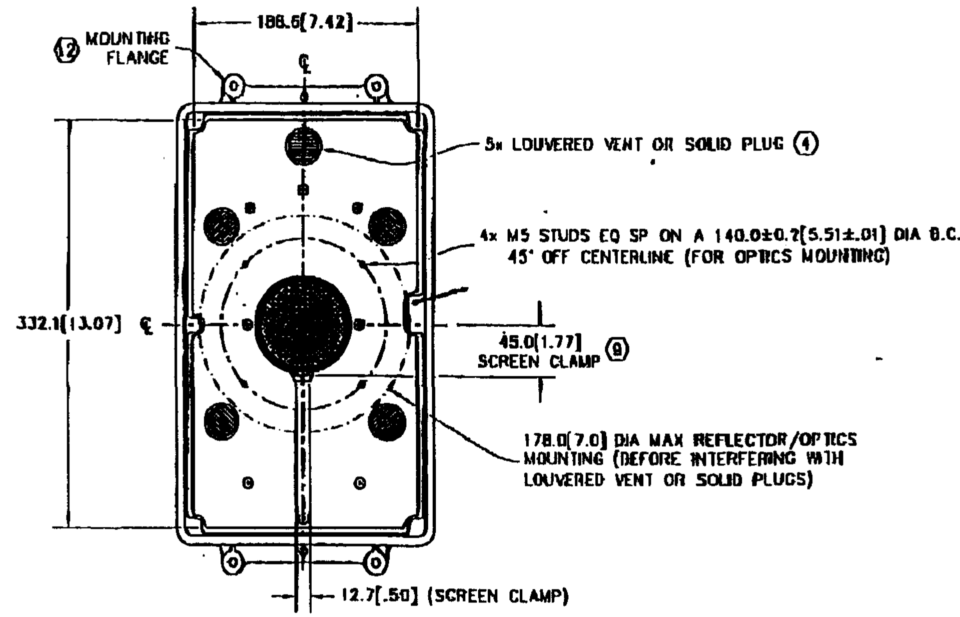
POS PK

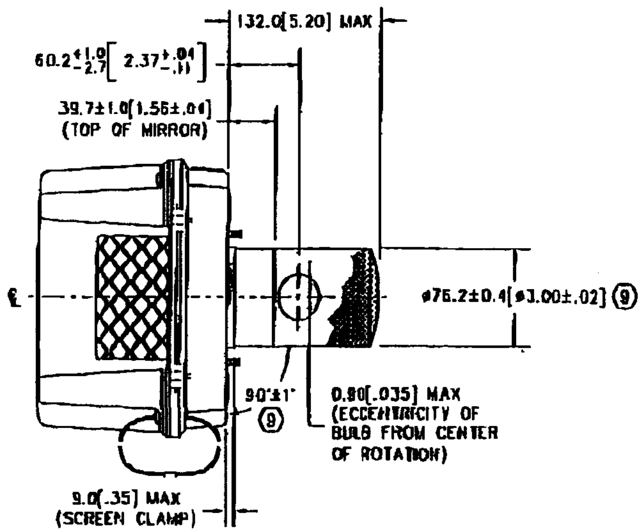
OFFSET
-33.0
dB



START 2.00 GHz
RES BW 1 MHz
VBW 1 MHz
STOP 3.00 GHz
SWP 25.0 msec







NOTES:

4 LOUVERED VENT PLUGS STANDARD w/ FUSION SUPPLIED REFLECTOR. SOLID PLUGS STANDARD w/o REFLECTOR. FREE AND UNOBSTRUCTED AIRFLOW IS REQUIRED BETWEEN LOUVERED VENT PLUGS AND FUSION SUPPLIED REFLECTOR.

9 CUSTOMER SUPPLIED REFLECTOR/OPTICS MUST ALLOW MINIMUM 1.0[.04] CLEARANCE AROUND RF SCREEN OR SCREEN CLAMP.

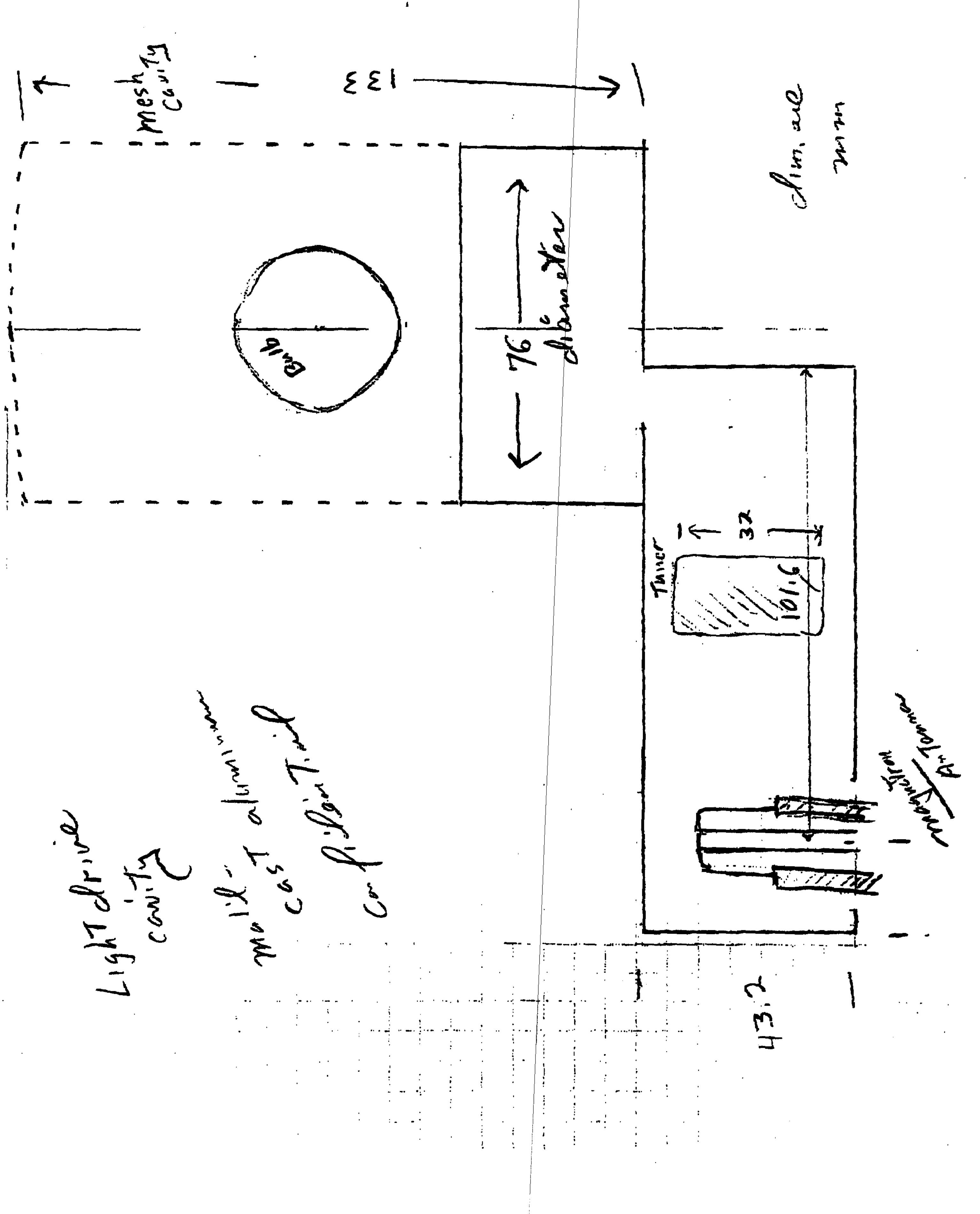
10 BULB O.D. IS FOR REFERENCE ONLY AND DOES NOT REPRESENT EFFECTIVE SOURCE DIAMETER.

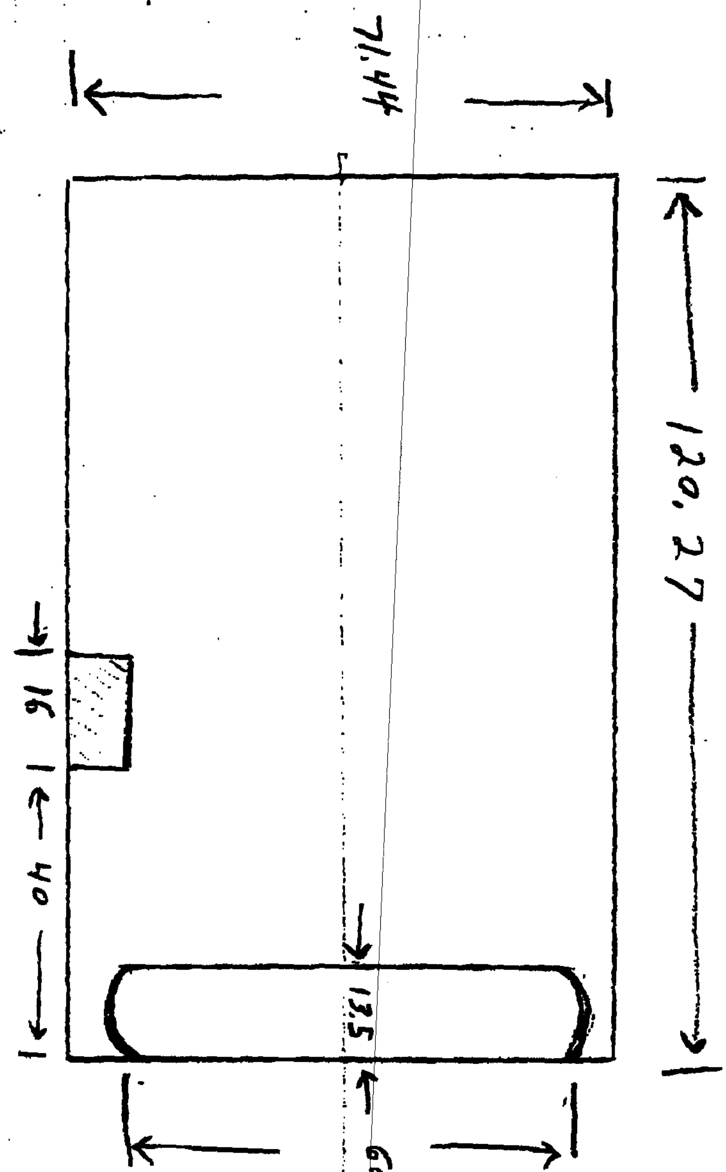
11 LAMP MUST NOT BE OPERATED WITH A DAMAGED RF SCREEN, MIRROR OR BULB.

12 LAMP HOUSING: REFER TO DRAWING 515502-S1 FOR DETAILS.

NOTE: ALL DIMENSIONS ARE IN mm [Inches]

Fusion Lighting, Inc. ROCKVILLE, MARYLAND, USA		
TITLE: OPTICAL INTERFACE, LIGHT DRIVE 1000		
DATE: 6/19/97	DWG. NO.: 515502-S2	REV: A


133
Mesh cavity
Bulb
76
diameter
dim. all mm
Tuner
32
101.6
magnetron Antenna
43.2
Light drive cavity
most likely aluminum cast configuration



Top View
W.G. only -
Bulb & upper cavity not shown

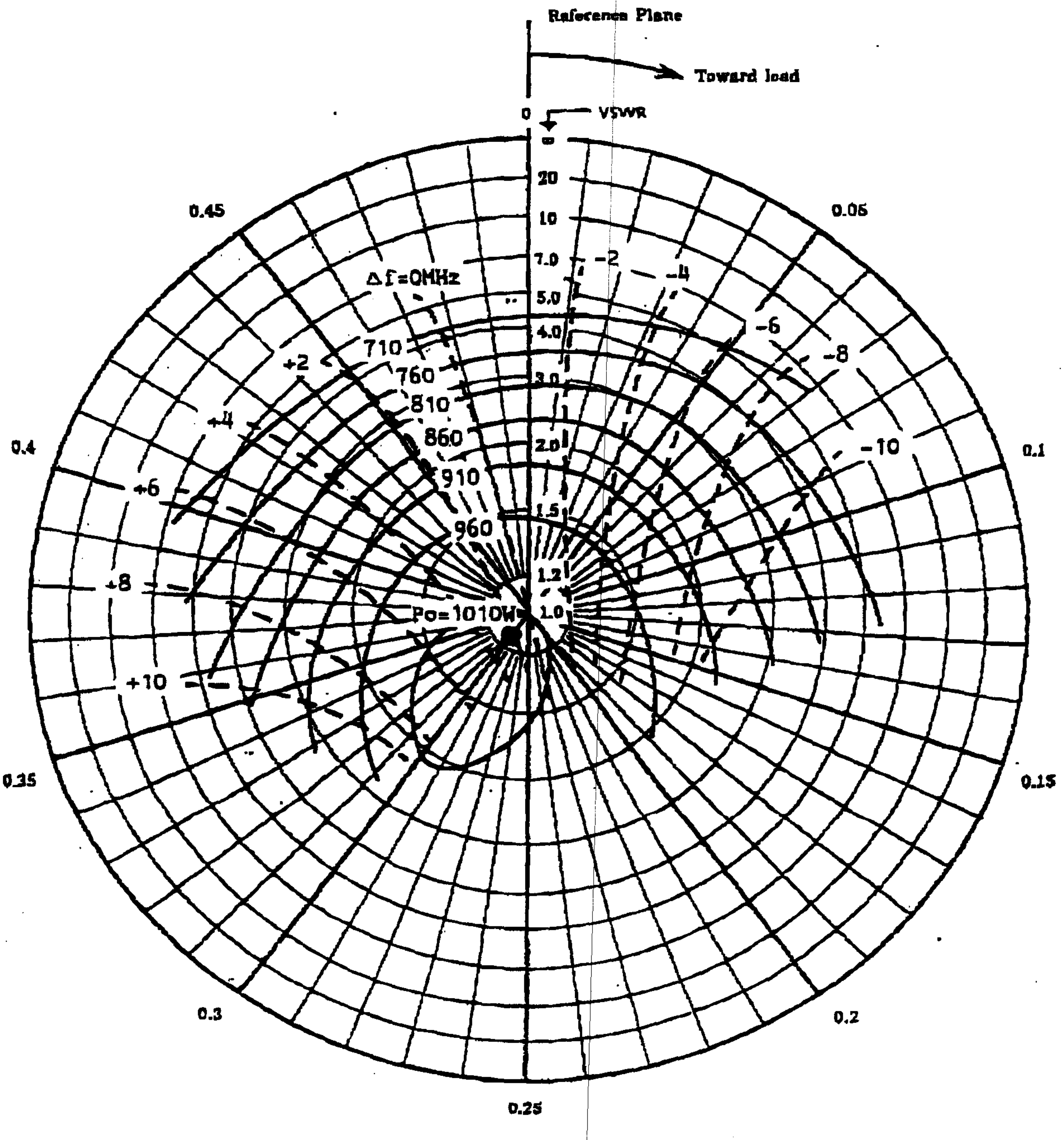
Confidential

PRODUCT SPECIFICATIONS	Spec No.	8078200 C	Page	4 / 6
	Model No.	2M244-M12E		

Fig.3 Typical Rike Diagram

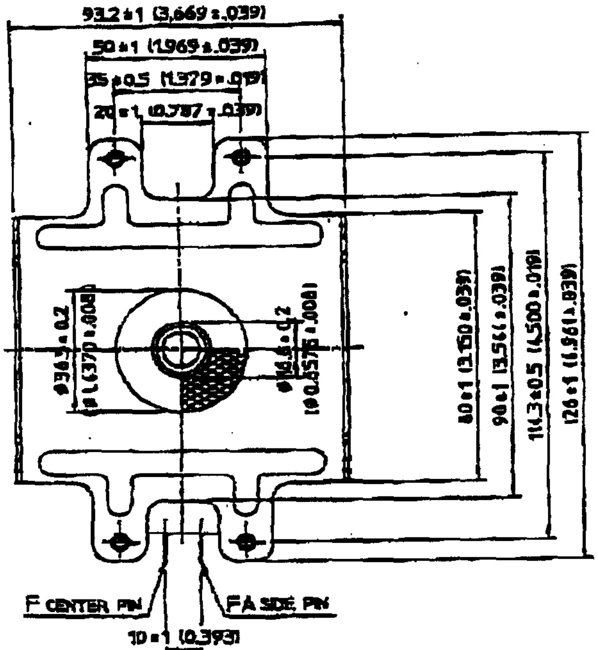
Anode supply : Single phase full wave rectifier without filter.
Filament voltage : 3.15 V
Mean anode current : 320 mA
Reference plane : Antenna

Matched load condition
Peak anode voltage : 4.35 kV
Mean output power : 1010 W
Frequency : 2455 MHz



OUTLINE DRAWING	Spec No.	8078200 D	Page	1 / 1
	Model No.	2M244-M12E		

Unit : mm (inch)

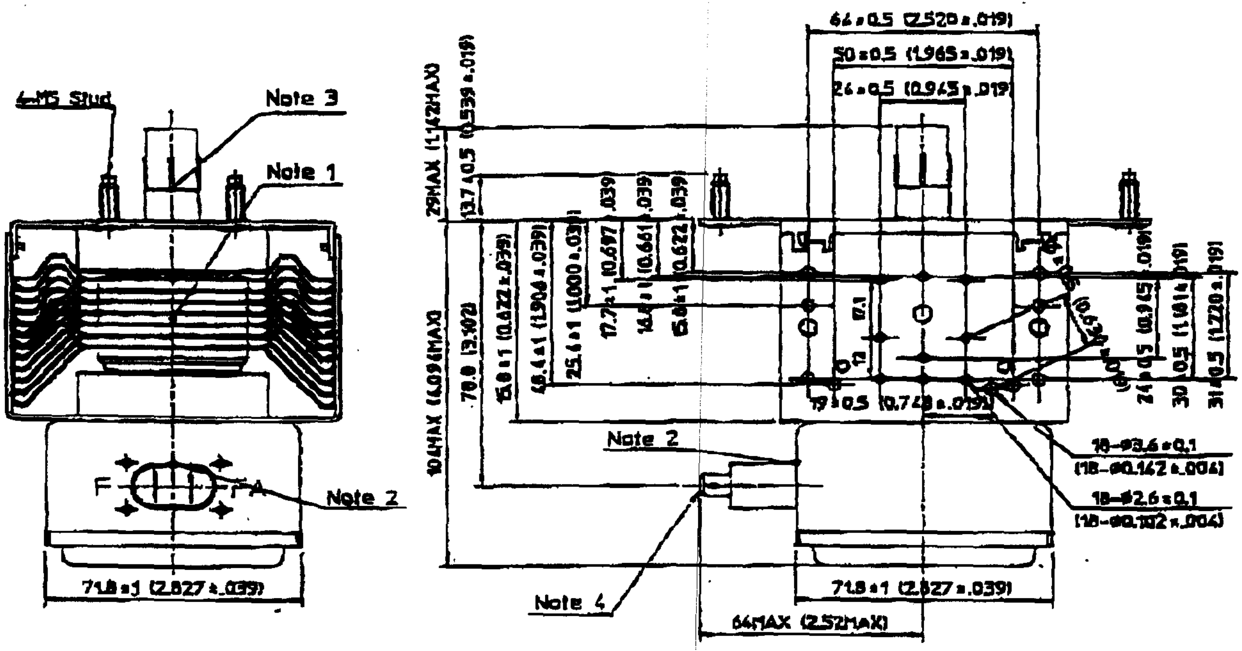


Note1. Anode temperature measuring point. To be measured at the outlet side of air flow.

Note2. Filter case temperature measuring point.

Note3. Antenna temperature measuring point.

Note4. Adaptable for ≠250 faston receptacle.



8/3/93					National/Panasonic

PRODUCT SPECIFICATIONS	Spec No.	8078200 C	Page	6 / 6
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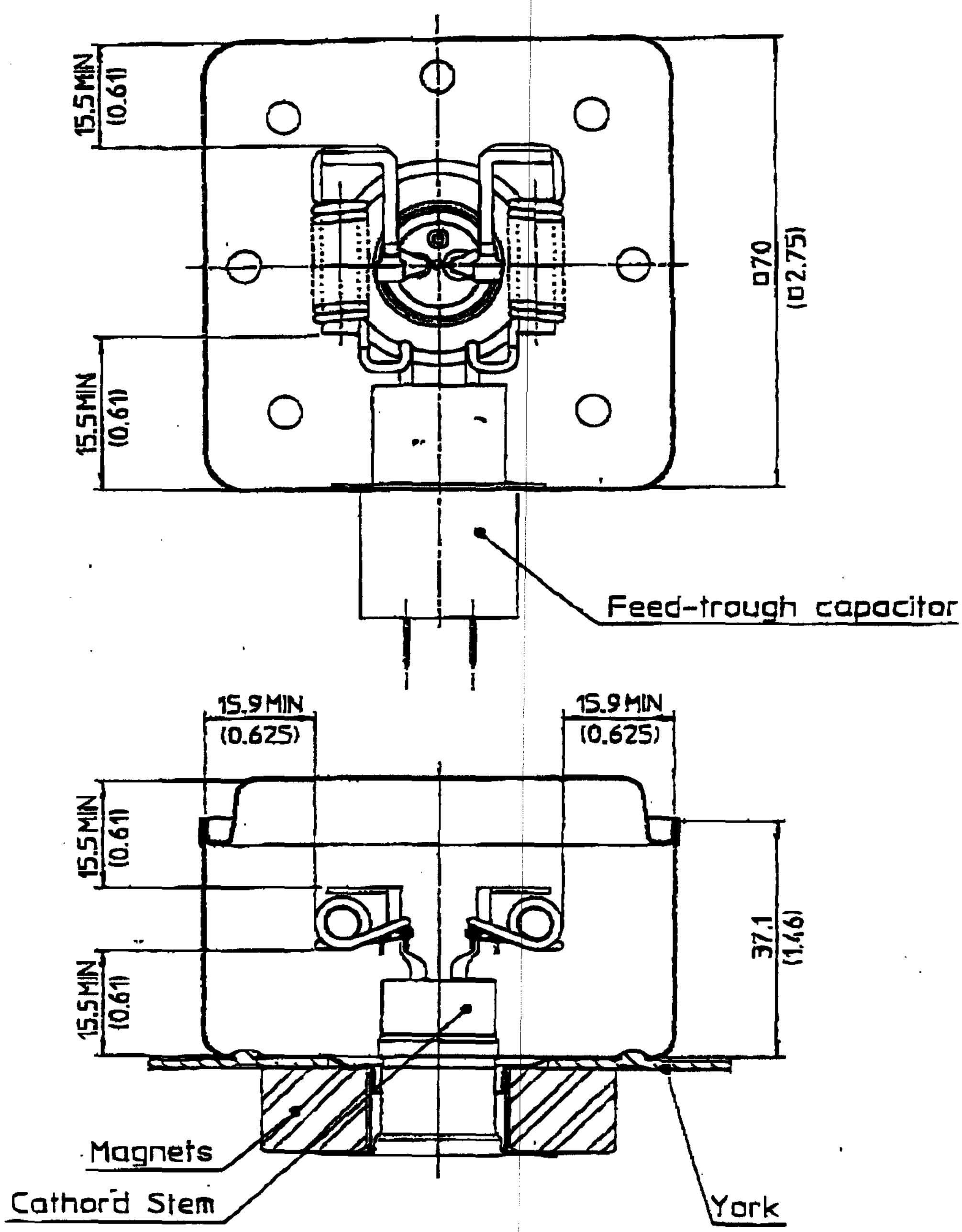
Fig.5 Creepage distance

Unit : mm (inch)



Creepage distance and clearances meet the conditions defined in "B.S. 3456 section 2-33 clause 29.1"

8/3/93					National/Panasonic

PRODUCT SPECIFICATIONS	Spec No.	8078200 C	Page	1 / 6
	Model No.	2M244-M12E		

This Specifications is based on the General Rules of Inspection for Electron Tubes ED-1101 and the Testing Methods for Continuous Wave Magnetrons ED-1501 set by the Electronic Industries Association of Japan (EIAJ).

Description	Continuous wave magnetron (Fixed Frequency, Packaged Magnet, Probe Output)												
Outline	Refer Outline Drawing				Net weight			Approx. 0.9kg					
Absolute Maximum Ratings	Item	Ef	tk	ebm	Ib	ibm	Pi	σL	Ta (5)	Tp (2)	Tc (2)	Storage
	Unit	V	sec	kV	mAdc	A	kW	-	°C	°C	°C	°C
	Max.	3.5	-	4.7	370	1.3	1.5	4	350	250 (3)	120 (4)	60
	Min.	2.8	0	-	-	-	-	-	-	-	-	-30
Standard Test Conditions (1)		3.15	3	-	320	-	-	MAX 1.1	-	-	-	-

Test Specifications

Test Item (8)		Test Method (ED-1501)	Test Conditions (1)	Symbol	Nominal	Limit Min.	Limit Max.	Unit
** Vibration		5.4.1	-	-	No unusual phenomenon occur			
Breakdown Voltage		4.2	Eb=10kVdc or 7.1kVac t=60s	BVaf	No unusual phenomenon occur			
* Filament Current		4.1.1.	tk=120s	If	10	8	12	A
Peak Anode Voltage		4.3.1	(6)	ebm	4.35	4.15	4.55	kV
Average Output Power (1)		4.3.3.1	(6)	Po(1)	1010	960	1060	W
Frequency		4.3.4	-	f	2455	2445	2465	MHz
* Load Characteristics	Puling Figure	4.3.6	σL=1.5	fpl	10	-	15	MHz
	Sink Phase	4.3.7	σL=4	λsink/λg	0.24	-	-	-
* Stability	Moding (1)	4.3.11.2	σL=2,3,4 t=60s	ST	No moding occur			
Emission Moding (2)		4.3.11.3	t≤5s, Ef=2.5V	Efm				
Fundamental Frequency Radiation		4.3.15	σL=4	S1	-	-	1	mW/cm²
* Surge Voltage		-	(7)	-	-	-	10	kV
Insulation		-	1kVdc	Raf	-	1000	-	MΩ
** Life Test		4.5.1	-	t	-	500	-	h
** Life Test End Point	Variation Rate against Average Output Power (1)	4.3.3.1	(6)	Po(1)	-	-	20	%
	Stability Moding (1)	4.3.11.2	σL=2,3,4 t=60s	ST	No moding occur			

EXHIBIT E

Comparison of Lamp and DARS Terrestrial Repeaters Emissions

Introduction

This analysis compares the radiated signal strength of terrestrial repeaters in the satellite Digital Audio Radio Service (DARS) frequency band with those of RF Lighting (RFL) Sources.

Analysis

Measured data of the radiated emissions of three RFL sources (lamps)[1], indicates that the radiated electric field strength at a distance of 3m from the lamp in a 1 MHz bandwidth in the frequency range of 2320-2345 MHz, based on the average of 3 measured values, is

$$E_{lamp}\ (3m) = 67 \text{ dB } \mu\text{V/m} = 2.24 \text{ mV/m}.$$

The power flux density (pfd) for a field strength of e V/m is given by, $\psi = e^2/Z_o\ W/m^2$, where $Z_o \approx 377\ \Omega$/square is the characteristic impedance of free space. In decibels, the lamp flux density at a distance of 3m is:

$$\Psi_{lamp}(3m) = 10 \log (0.00224^2/377) = -78.8\ dBW/m^2$$

The power flux density from a terrestrial repeater depends on its transmitter power, p_t watts, the antenna gain, g_t, and the distance from the antenna, d meters according to:

$$\psi_{repeater}(d) = p_t g_t/(4\pi d^n).$$

The flux density at distance, d, in dBW/m^2, is:

$$\Psi_{repeater} = 10 \log (p_t g_t) - 10 \log (4\pi) - 10(n) \log(d)$$

$$\Psi_{repeater} = EIRP - 10.99 - 10(n) \log(d)$$

EIRP is the equivalent isotropically radiated power, i.e. the dB sum of the transmit power, $P_t = 10 \log(p_t)$ dBW and the antenna gain, $G_t = 10 \log(g_t)$ dBi. The "path loss" exponent, n, indicates the rate at which the signal decreases with distance. For propagation in free space, n=2. For propagation in an urban environment, this exponent is usually taken as a larger number, ranging from 2.7 to as high as 6 to account for shadowing and reflections from buildings and other obstructions[2].

While a more rigorous analysis would include statistical information such as the percentage of users having a signal that is above a given threshold level for a distribution of users at various distances from repeaters and lamps in various urban environments, useful comparisons can be made on the basis of the simple exponential model defined here.

---

[1] PCTEST Lab, Columbia, MD, *Product Evaluation Report, Manufacturer: Fusion Lighting, Inc.*, RF Lighting (6 Lamps), Test Report S/N: 18A.201102546.FLI, November 3, 2000. While 6 measured values are shown in the report, Fusion Lighting contends that the most recently manufactured ones are the most representative of lamps that will be manufactured and deployed.

[2] T.S. Rappaport et al, "Propagation Models", *The Communications Handbook*, J. D. Gibson, Editor-in-Chief, CRC Press, Boca Raton, FL, 1997, pp. 1188-1189.

For this comparison, values of the exponent of n=2, n=3, and n=4 are chosen. It is further assumed that the transmitter antenna has a numerical gain, g_t, of 2 (G_t=10 log(g_t)=3 dBi). Values of repeater transmitter power of 1 kW, 10 kW, and 40 kW are examined.

For each case of transmitter power and exponent, the power flux density of the repeater at various distances is plotted to show its level relative to that at 3m from the lamp. Figure 1 depicts the flux density vs. repeater distance for a transmitter power of 40 kW.

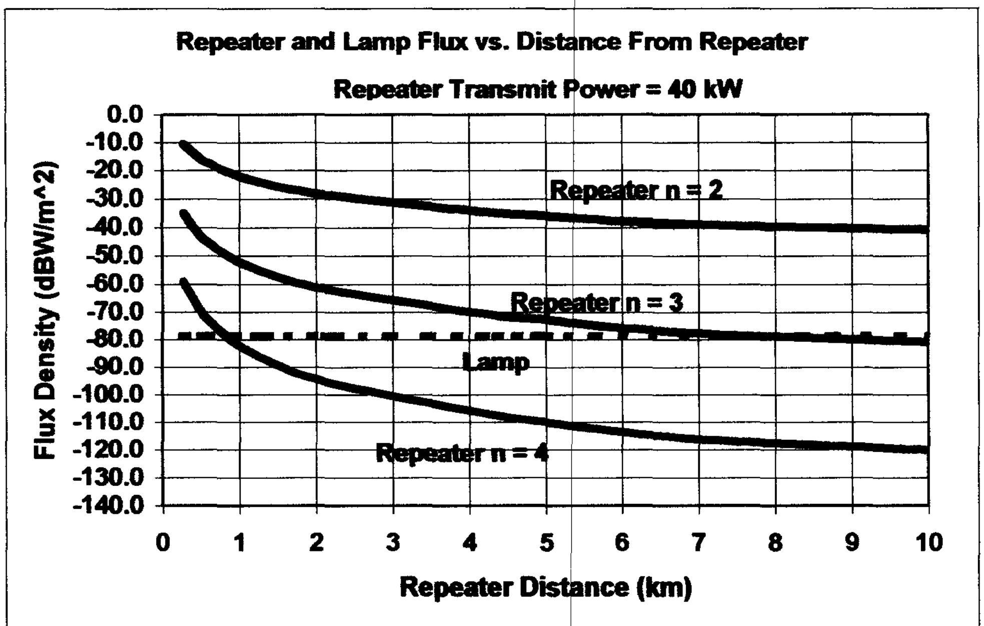


Figure 1. Repeater and Lamp Comparison for a 40 kW Repeater.

Figure 2 depicts the comparison for a 10 kW transmitter and Figure 3 shows the comparison for a 1 kW repeater.

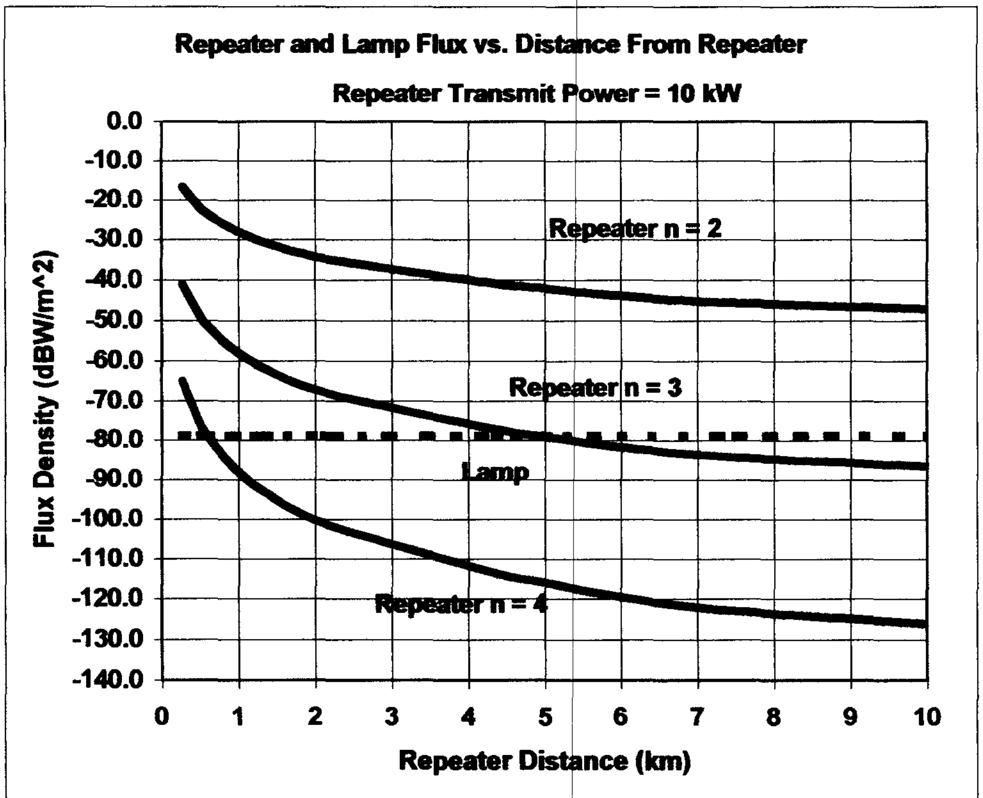


Figure 2. Repeater and Lamp Comparison for a 10 kW Repeater.

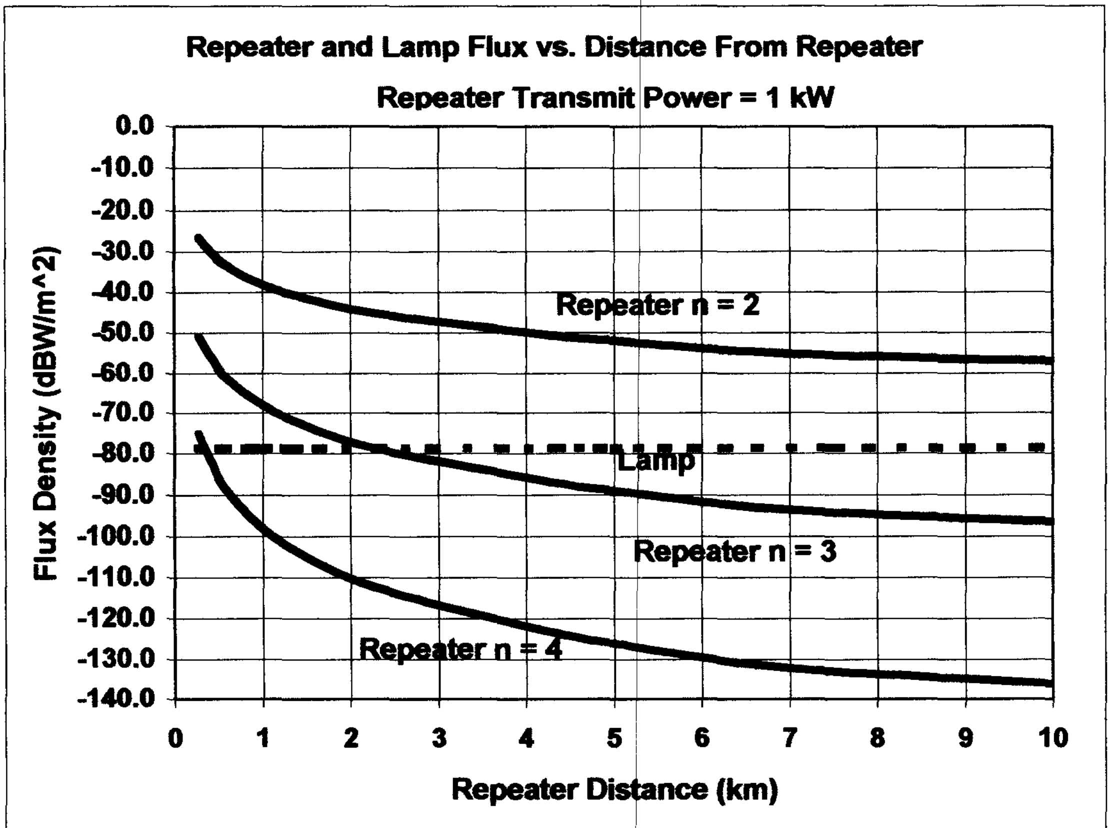


Figure 3. Repeater and Lamp Comparison for a 1 kW Repeater.

Impact

One measure of the relative impact of the lamp interference into the DARS repeater signals would be to determine the distance from the repeater within which the repeater signal is greater than the lamp noise by a given factor.

The factor depends on the transmission parameters, or link budget, of the system. Consider a system with a ratio of signal carrier power to thermal noise power, given by C/N =10 log(c/n) dB, in the absence of interference. An uncorrelated interfering noise power such that the ratio of signal carrier power to interference power C/I = 10 log(c/i), will degrade the ratio of signal carrier power-to noise plus interference power according to:

$$c/(n+i)=[(c/n)^{-1} + (c/i)^{-1}]^{-1}$$

$$C/(N+I) = 10 \log(c/(n+i)) \text{ dB}$$

Figure 4 depicts the net C/(N+I) vs. C/N for several values of C/I. For example, a system with C/N = 10 dB that experiences interference such that C/I = 10 dB (i.e. the signal power is 10 times that of the interference) would have a net C/(N+I) of 7 dB. This would reduce the net link margin by 3 dB. The severity of this impact to system performance such as availability and signal quality would depend on the system transmission parameters and receiver characteristics.

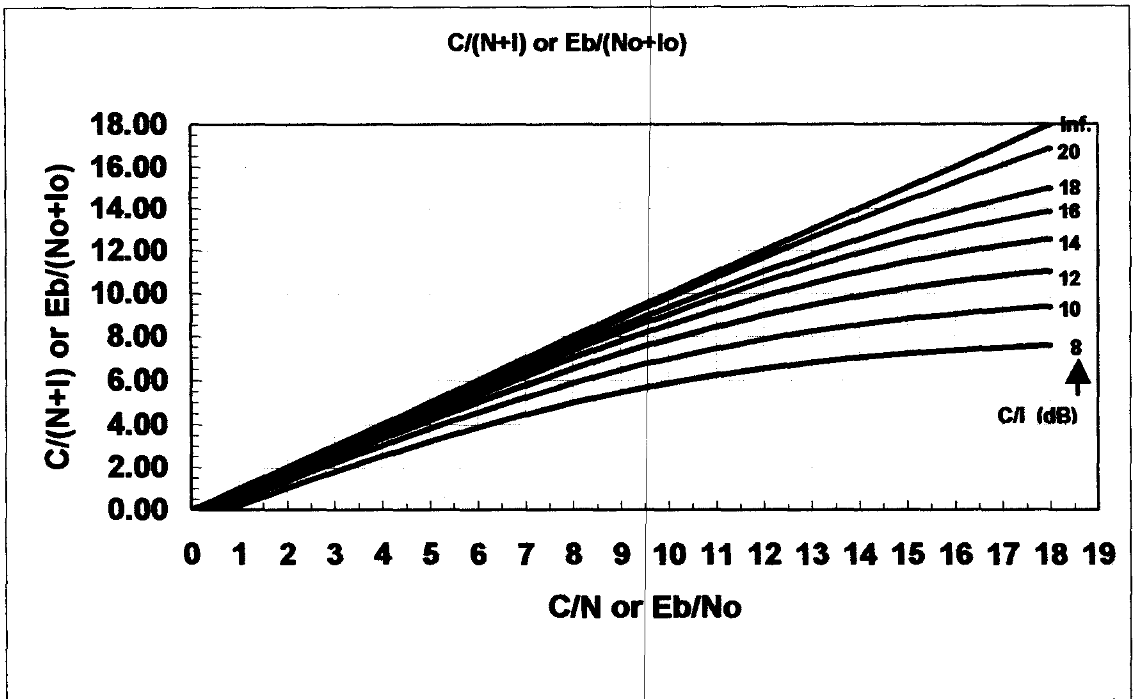


Figure 4. Impact of Interference on Total C/(N+I)

Based on Figures 1-3, one useful metric for the lamp impact is the repeater distance at which the repeater flux density is equal to that of the lamp. At closer distances the repeater signal is stronger than that of the lamp.

Another criterion could be the distance at which the repeater is stronger by a specified amount. While that must be determined by a careful examination of the system transmission parameters, a useful example is the case for which the interference power is 10 dB below that of the carrier (C/I=10 dB).

While this level of interference is greater than that which would require coordination if the interference were to come from another satellite system, it must be noted that the lamps are not ubiquitous, as would be the signals from another satellite system. Therefore, the 10 dB level may not be unreasonably high because the statistical impact of this spatially non-uniform interference on overall availability would be less severe than that of a ubiquitous interference source.

Table 1 summarizes the repeater distances for equal flux densities and for the case where the interference flux density is 10 dB below that of the lamp for n=2 and n=3 and for repeater powers of 1 kW, 10 kW, and 40 kW.

Table 1. Summary

Repeater Power (kW)	1	10	40	1	10	40
Repeater "path loss" exponent	[redacted]	[redacted]	[redacted]	3	3	3
Repeater distance at which lamp and repeater flux densities are equal (km)	109	346	691	2.3	4.9	7.8
Repeater distance at which repeater flux density is 10 dB higher than that of the lamp (km)	35	109	219	1	2.3	3.6

Daniel F. DiFonzo

Daniel F. DiFonzo,
President
Planar Communications Corporation
31 May 2001